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The Department of Defense

DEPARTMENT/AGENCIES PARTICIPATING:

Department of the Army

Department of the Navy

DARPA

Defense Advanced Research Projects Agency

PROGRAM SOLICITATION 90.2
Closing Date: 2 July 1990

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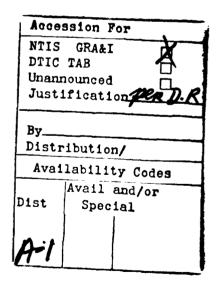# SMALL BUSINESS
INNOVATION
RESEARCH (SBIR)
PROGRAM

PROGRAM SOLICITATION

Number 90.2

Small Business
Innovation
Research Program

Issue Date: May 1, 1990

U.S. Department of Defense

SBIR Program Office

Washington, DC 20301

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, and Defense Advanced Research Projects Agency (DARPA), hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Appendix D are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense related scientific or engineering problems.

Objectives of the DoD SBIR Program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DOD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD supported research or research and development results. (SI) F

The Federal SBIR Program is mandated by Public Laws PL 97-219 and PL 99-443. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, June 1988. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD. Results from prior years are shown in Reference A at the back of this solicitation.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219 and PL 99-443. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results have the potential to yield a product or process of continuing importance to DoD. Proposers are asked to consider whether the research and development they are proposing to DoD Components also has commercial possibilities, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms only on the basis of results from the Phase I effort, and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, subject to negotiation. Phase II is the principal research or research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, non-federal capital is expected to be used by the small business to pursue commercial applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed in part, to provide incentives for the conversion of federally sponsored research and development innovation in the private sector. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified

proposal if it is responsive to any of the topics listed in Appendix D hereto.

For Phase II, no separate solicitation will be issued as only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II or III. DoD is not responsible for any monies expended to the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research development, another important goal of the program is conversion of DoD supported research or research and development into technological innovation by private firms. Therefore, on an optional basis, the DoD Program includes an incentive for proposers to obtain a contingent commitment for private follow-on funding prior to Phase II to continue the innovation process where it is felt that the research or research and development also have commercial potential.

Proposers who feel that their research or research and development have the potential to meet market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for I hase III to pursue commercial development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent on the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. Note that when several Phase II proposals are evaluated as being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in this solicitation Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer.

For both Phase I and Phase II the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act. 15 USC 631, and the definition included in this solicitation.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. Oral Communications. Oral communications with DoD Components regarding this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness, with the exceptions as stated in Section 1.6, 7.0, and Appendix D of this program solicitation.

b. Contacts for General Information of This Solicitation. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
OSD/SADBU
U.S. Department of Defense
The Pentagon - Room 2A340
Washington, DC 20301-3061
(202) 697-1481

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Appendix D of this solicitation.

c. Requests for Additional Copies of This Solicitation. Additional copies of this solicitation may be ordered from the Defense Technical Information Center: Attn: DTIC/SBIR, Building 5 Cameron Station, Alexandria, Virginia 22304-6415; telephone toll free (800) 368-5211 commercial for Virginia, Alaska and Hawaii (202) 274-6902.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - A systematic, intensive study directed toward greater knowledge or understanding of the subject studied.

Exploratory Development - A systematic study directed specifically toward applying new knowledge to meet a recognized need.

Advanced Development or Engineering Development - A systematic application of knowledge towards the production of useful materials, devices and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Minority and Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by one or more minority and disadvantaged individuals; or, in the case of any publicly owned business, at least 51% of the voting stock of which is owned by one or more minority and disadvantaged individuals; and

b. Whose management and daily business operations are controlled by one or more of such individuals.

While these individuals and small concerns will be required to compete for SBIR on the same basis as all other small businesses, attention will be given to a special outreach effort to ensure that minority and disadvantaged firms will have notice of this solicitation.

A minority and disadvantaged individual is defined as a member of any of the following groups; Black Americans; Hispanic Americans; Native Americans; Asian-Pacific Americans; or subcontinent-Asian Americans.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

3.0 PROPOSAL PREPARATIONS INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents a sound approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the technological innovation, new commercial products, process, or services which benefit the public.

Those responding to this solicitation should note the proposal preparation tips listed below:

· Read and follow all instructions contained in this solicitation; including those contained in Appendix D.

· Use the free technical information services from DTIC (Section 7.5) and also the free assistance available at the DCAS near you (Section 7.3).

· Mark proprietary information as instructed in Section 5.5.

· Limit your proposal to 25 pages.

· Don't include proprietary information in the project summary (Appendix B).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise and informative research or research and development proposal of no more than 25 pages, (no type smaller than elite on standard 8¾" X 11" paper with one (1) inch margins, 6 lines per inch) including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments. Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, no additional attachments, appendices or references beyond the 25 page limitation will be considered in proposal evaluation, and proposals in excess of the 25 page limitation will not be considered for review or award.

The proposal must address the research or research and development proposed on the specific topic chosen. It is not necessary to provide a lengthy discourse on the commercial applications in the Phase I proposal except to discuss briefly as described in Section 3.4, items b and h.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered.

a. **Cover Sheet.** Complete Appendix A, photocopy the completed form and use it as Page 1 of each copy of your proposal.

b. **Project Summary.** Complete and photocopy the form identified as Appendix B as Page 2 of each copy of your proposal. The technical abstract should include a brief description of the project objectives, and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, will not contain proprietary or classified information.

c. **Identification and Significance of the Problem or Opportunity.** Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. **Phase I Technical Objectives.** Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. **Phase I Work Plan.** Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. **Related Work.** Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, by the proposing firm, consultants, or others, how it interfaces with the proposed project, and any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Use of DTIC is encouraged.

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g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Briefly describe:

(1) Whether and by what means the proposed project appears to have potential use by the Federal Government.
(2) Whether and by what means the proposed project appears to have potential commercial application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this Section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail, and identified in Appendix C. A minimum of two-thirds of each SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been or is funded by, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, or will be submitted or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.

(5) Title, number, and date of solicitation(s) under which the proposal was submitted or will be submitted or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, please state in the proposal "No prior, current or pending support for a similar proposal."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds, will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

A Phase II proposal can be submitted only by a Phase I awardee. Phase II is not initiated by a solicitation, but a proposal must contain a Cover Sheet (Appendix A) and a Project Summary Sheet (Appendix B) of this solicitation. Copies of Appendixes along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors, including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research, or research and development, program balance, budget limitations and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced a debriefing may be provided to unsuccessful offerors, on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government with approximately equal consideration given to each of the following criteria, except for item a., which will receive twice the weight of any other item.

   a. Scientific/technical quality of the Phase I research or research and development proposal and its relevance to the topic description, with special emphasis on its innovation and originality.

   b. Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.

   c. Anticipated benefits of the research or research and development to the total DoD research and development effort.

   d. Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referred to experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below. Each item will receive approximately equal weight, except for item a., which will receive twice the value of any other item:

   a. Anticipated benefits of the research or development to the total DoD research and development effort.

   b. Scientific/technical quality of the proposal, with special emphasis on its innovation and originality.

   c. Qualifications of the principal investigator and other key personnel to carry out the proposed work.

   d. Degree to which the Phase I objectives were met at the time of Phase II proposal submission.

   e. Adequacy of the Phase II objectives to meet the opportunity or solve the problem.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

In the case of proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for a continued development from non-federal funding sources will be a special consideration. The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. **Number of Phase I Awards.** The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than January 2, 1991. The name of those firms selected for awards will be announced. The DoD Components anticipate making 1300 Phase I awards during Fiscal Year 1990.

b. **Type of Funding Agreement.** All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects. Note: The firm fixed price contract is the preferred type for Phase I.

c. **Average Dollar Value of Awards.** DoD Components will make Phase I awards to small businesses typically on one-half person-year effort over a period generally not to exceed six months, subject to negotiation. The legislative history of PL 97-219 and PL 99-443 clearly envisioned a large number of Phase I awards up to $50,000 each, adjusted for inflation.

5.2 Awards (Phase II)

a. **Number of Phase II Awards.** The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. The DoD Components anticipate making 450 Phase II awards during Fiscal Year 1990.

b. **Type of Funding Agreement.** Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. **Project Continuity.** Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II work and the costs associated therewith. These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the government, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract.

d. **Average Dollar Value of Awards.** Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific and technical merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, subject to negotiation. The legislative history of PL 97-219 and PL 99-443 clearly envisioned that the Phase II awards would be up to $500,000 each, adjusted for inflation.

5.3 Reports

Six copies of a final report on the Phase I project must be submitted to the DoD Component in accordance with the negotiated delivery schedule. This will normally be within thirty days after completion of the Phase I technical effort. The final report shall include a completed SF 298, "Report Documentation Page" as the first page identifying the purpose of the work, a brief description of the work carried out, the findings or results, and potential applications of the effort. The summary may be published by DoD and therefore must not contain proprietary or classified information. The balance of the report should indicate in detail the project objectives, work carried out, results obtained, and estimates of technical feasibility.

To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes only to accommodate results obtained after Phase II proposal submission, and modifications required to integrate the final report into a self-contained, comprehensive and logically structured document.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 85% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend appears on the title page of the proposal:

"For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)_____of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

"Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a reasonable time period to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the government shall have the limited right to use such data for government purposes and shall not release such data outside the government without permission of the contractor for a period of two years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the two-year period, the government shall retain a royalty-free license for government use of any technical data delivered under an SBIR contract whether patented or not.

5.9 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Paragraph 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay.)

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bonafide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below.

6.1 Address

Proposals (5 copies) and modifications thereof must be addressed to that DoD Component address which is identified for the specific topic in that Component's section of Appendix D to this solicitation.
One copy must be an original signed by the principal investigator and an official empowered to commit the proposer. Other copies may be photocopied.
The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.
Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secure packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.
All copies of a proposal must be sent in the same package. Do not send separate "information" copies or several packages containing parts of the single proposal.

6.2 Deadline for Proposals

Deadline for receipt (5 copies) at the DoD Component is 2:00 p.m. local time, July 2, 1990. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than June 26, 1990 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term "postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye "postmark" on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.
Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term "telegram" includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages. Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference B) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced a debriefing may be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number, specific topic number and be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small business may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DoD. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DoD sponsored Information Analysis Centers (IACs) where specialists in mission areas assigned to these IACs perform informational and consultative services.

Many of the small business requesters who responded to previous DoD SBIR Program solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DoD funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DoD sponsored work currently in progress in their proposal topic areas.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DoD. Call or visit DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA address.

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 368-5211 (toll free)
(202) 274-6902 (Commercial for Virginia,
                    Alaska and Hawaii)

DTIC Boston On-Line Service Facility
DTIC-BOS
Building 1103, Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
AFWL/SUL Bldg. 419
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles On-Line Service Facility
Defense Contract Administration Services Region
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4320
(213) 335-4170

Use Reference C at the back of this solicitation or telephone DTIC to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible. To assure the fastest possible mail service, give DTIC your Federal Express Account Number to which mailing charges will be made for overnight delivery.

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

Aerospace Research Applications Center
P.O. Box 647
Indianapolis, IN 46223
(317) 264-4644

Central Industrial Applications Center
Southeastern Oklahoma State University
Durant, OK 74701
(405) 924-6822

Information Strategists
814 Elm Street
Manchester, NH 03101
(603) 624-8208

NASA/Florida State Technology Applications Center
State University System of Florida, Progress Center
1 Progress Blvd., Box 24
Alachua, FL 32615
(904) 462-3913

NASA Industrial Applications Center
823 William Pitt Union
University of Pittsburgh
Pittsburgh, PA 15260
(412) 648-7000

NASA/UK Technology
University of Kentucky
109 Kinkead Hall
Lexington, KY 40506
(606) 257-6322

NERAC, Inc.
1 Technology Drive
Tolland, CT 06084
(203) 872-7000

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

North Carolina Science and Technology Research Center
P.O. Box 12235
Research Triangle Park, North Carolina 27709
(919) 549-0671

Western Research Applications Center (WESRAC)
University of Southern California
3716 S. Hope Street #200
Los Angeles, California 90007
(213) 743-6132

7.3 Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Administration Services (DCAS) activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference D at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to DCAS Activities.)

8.0 TECHNICAL TOPICS

Topics for each DoD Component are listed and numbered separately. Topics, topic descriptions, and addresses of organizations to which proposals are to be submitted are provided in Appendix D. Also included in Appendix D are instructions for contacting each DoD Component.

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to fill in all appropriate boxes may cause your proposal to be disqualified

TOPIC NUMBER: _____

PROPOSAL TITLE: _____

_____

FIRM NAME: _____

MAIL ADDRESS: _____

_____

CITY: _____ STATE: _____ ZIP: _____

PROPOSED COST: _____ PHASE I OR II: _____ PROPOSED DURATION:
                                       PROPOSAL   IN MONTHS _____

BUSINESS CERTIFICATION: YES   NO

▶ Are you a small business as described in paragraph 2.2?   ☐   ☐

▶ Are you a minority or small disadvantaged business as defined in paragraph 2.3?   ☐   ☐

▶ Are you a woman-owned small business as described in paragraph 2.4?   ☐   ☐

▶ Will you permit the government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment?   ☐   ☐

▶ Has this proposal been submitted to other US government agency/agencies, or DoD components, or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office in the spaces to the left below. If it has been submitted to another SBIR activity list the Topic Numbers in the spaces to the right below: ☐   ☐

_____   _____

_____   _____

▶ Number of employees including all affiliates (average for preceding 12 months) _____

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: _____	NAME: _____
TITLE: _____	TITLE: _____
TELEPHONE: _____	TELEPHONE: _____

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: _____

DISCLOSURE PERMISSION STATEMENTS: All data on Appendix A are releasable. All data on Appendix B, of an awarded contract, are also releasable.

_____ _____ _____ _____
SIGNATURE OF PRINCIPAL INVESTIGATOR   DATE   SIGNATURE OF CORPORATE BUSINESS OFFICIAL   DATE

Nothing on this page is classified or proprietary information/data.

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

TOPIC NUMBER: _____

PROPOSAL TITLE: _____

_____

FIRM NAME: _____

PHASE I or II PROPOSAL: _____

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

_____   _____

_____   _____

_____   _____

_____   _____

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PHASE I-FY1990
COST PROPOSAL

Background:

--The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate)

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
    a. Purchased parts (dollars)
    b. Subcontracted items (dollars)
    c. Other
        (1) Raw material (dollars)
        (2) Your standard commercial items (dollars)
        (3) Interdivisional transfers (at other than cost dollars)
    d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
    a. Type of labor, estimated hours, rate per hour and dollar cost for each type
    b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars)
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

APPENDIX D

Technical Topics

Topics for each DoD components are listed and numbered separately along with instructions for submission of proposals:

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INTRODUCTION

This second SBIR solicitation for FY 1990 contains a broad range of topics from Army laboratories and centers. A total of 479 topics has been solicited under the Army SBIR Program this year for publication in the two DOD SBIR books. We plan to award contracts for this second solicitation (A207-A479) in the fall of this year. Such a schedule will link SBIR with the normal fiscal year cycle (October 1990 to September 1991) of the Army.

All 479 topics received an additional Washington level review this year to focus the work on potential benefits to the Army in Phase Two and Phase Three. This same review panel will oversee Phase Two project proposals with an eye toward Phase Two/Phase Three payoffs. The Phase One selections will remain decentralized with selections made by the individual laboratories and centers where you send your proposals. Refer to your point of contact page for telephone numbers for general inquiries.

Please remember to contact Defense Technical Information Center at 800-368-5211 for additional information on these topics including relevant technical reports. Good luck and thank you for participating in the Army SBIR Program.

J. Patrick Forry

Army SBIR Program Manager

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ARMY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Army Topics

Phase 1 proposal (5 copies) should be addressed to :

Belvoir Research, Development and Engineering Center

Topic Nos. A90-207 through A90-213

		Administrative
Mail Address		SBIR Contact
Commander		C. Harrison
U.S. Army Belvoir RD&E Center		703-664-1068
ATTN: AMSTR-PBP, SBIR Program		
Bldg 314, Procurement Receptionist		
Ft. Belvoir, Va 22060-5606		

Communication Electronics Command

Topic Nos. A90-214, 216, 218-224, 226-230, 233-236, 239-244, 246, 248-250

Mail Address

Commander	J. Crisci
U.S. Communications-Electronics Command	201-544-2665
ATTN: AMSEL-PCCC-BID, SBIR Program	
Tinton Avenue	
Fort Monmouth, NJ 07703-5000	

Topic Nos. A90-215, 225, 232, 238, 245 and 247

Mail Address

Director	J. Crisci
U.S. Army Center for Night Vision & Electro-Optics	201-544-2665
ATTN: AMSEL-RD-NV-RM-FP	
SBIR Program (Linda Kline) (Bldg 305)	
Fort Belvoir, Va 22060-5677	

Topic Nos. A90-217, 231, and 237

Mail Address

Director	J. Crisci
U.S. Army Center for Signals Warfare	201-544-2665
ATTN: AMSEL-RD-SW-DTI	
SBIR Program (Linda Monroe)	
Vint Hill Farms Station (Bldg 260)	
Warrenton, Va 22186-5100	

Chemical Research Development and Engineering Center

Topic Nos. A90-251 through A90-258

Mail Address

Commander	R. Hinkle
U.S. Army Chemical Research, Development	301-671-2031
and Engineering Center	
ATTN: AMSMC-PC-B(A)	
Procurement Directorate	
Edgewood Site/BLDG 4455	
Aberdeen Proving Ground, Md 21010-5423	

U.S. Army Missile Command

Topic Nos. A90-259 through A90-268

Mail Address

Administrative
SBIR Contact

Commander   J. Fulda
U.S. Army Missile Command   205-876-4684
ATTN: AMSMI-PC-FB
Bldg 4488, SBIR Program
Redstone Arsenal, AL 35898-5280

U.S. Army NATICK Research Development and Engineering Center

Topic Nos. A90-269 through A90-275

Mail Address

Commander   R. Rosenkrans
U.S. Army Natick Research and Development   508-651-5296
  and Engineering Center
ATTN: AMSTR-PN, SBIR Program
Natick, MA 01760-5011

Topic Nos. A90-276 through A90-287

Mail Address

Commander   R. Hostetler
U.S. Army Tank-Automotive Command   313-574-5270
ATTN: AMSTA-IRSA
Bldg 200A, SBIR Program
Warren, MI 48397-5000

U.S. Army Test and Evaluation Command

Topic Nos. A90-288, 293-294, and 297

Mail Address

Commander   S. Marshall
U.S. Army Aberdeen Proving Ground Support Activity   301-278-3906
Directorate of Contracting
ATTN: STEAP-DOC (SBIR Program)
Ryan Building, Rm 124
Aberdeen Proving Ground, MD 21005-5001

Topic Nos. A90-295

Mail Address

Commander   S. Marshall
U.S. Army Electronic Proving Ground   301-278-3906
ATTN: STEEP-MO (SBIR Program)
Greely Hall
Fort Huachuca, AZ 85613-7110

Topic Nos. A90-289, 291-292, 298-301

Mail Address	Administrative SBIR Contact
Commander U.S. Army White Sands Missile Range Directorate of Contracting ATTN: STEWS-PR (SBIR Program) Building 126 White Sands Missile Range, NM 88002-5201	S. Marshall 301-278-3906

Topic Nos. A90-290 and 296

Mail Address	
Commander U.S. Army Yuma Proving Ground Directorate of Contracting ATTN: STEYP-CR (SBIR Program) Building 2100, Room 11 Yuma Proving Ground, AZ 85365-9102	S. Marshall 301-278-3906

Ballistic Research Laboratory

Topic Nos. A90-302 through A90-305

Mail Address	
Commander U.S. Army Armament, Munitions and Chemical Command Procurement Directorate ATTN: AMCMC-PCM(A), SBIR Program, Ballistics Research Laboratory (BRL) Edgewood Site, Bldg E4455 Aberdeen Proving Ground, MD 21010-5423	R. Dimmick 301-278-6955

Topic Nos. A90-306 through A90-311

Mailing Address	
Commander U.S. Army White Sands Missile Range Directorate of Contracting ATTN: STEWS-PR, Atmospheric Science Laboratory (ASL) SBIR Program White Sands Missile Range, NM 88002-5031	O. Johnson 505-678-3608

Topic Nos. A90-312 through A90-322

Mailing Address	
Commander U.S. Army Electronics Technology and Devices Laboratory (ETDL) ATTN: SLCET-DT, SBIR Program Ft. Monmouth, NJ 07703-5000	R. Stern 201-544-4666

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Topic Nos. A90-323 through A90-356

	Administrative
Mailing Address	SBIR Contact

Director Harry Diamond Laboratory ATTN: SLCHD-PO-P SBIR Program 2800 Powder Mill Road Adelphi, MD 20783-1197	J. Sattler 301-394-2002

Topic Nos. A90-357 through A90-364

Mailing Address

Commander U.S. Army Armament, Munitions and Chemical Command Procurement Directorate ATTN: AMCMC-PCA(A), SBIR Program, Human Engineering Laboratory (HEL) Edgewood Site, Bldg E4455 Aberdeen Proving Ground, MD 21010-5423	J. Sissum 301-278-5815

Materials Technology Laboratory

Topic Nos. A90-365 through A90-375

Mailing Address

Director U.S. Army Materials Technology Laboratory (MTL) ATTN: SLCMT-TMT, Management Branch 405 Arsenal Street Bldg 131, Rm 144, SBIR Program Watertown, MA 02172-0001	R. Morrissey 617-923-5522

Vulnerability Assessment Laboratory

Topic Nos. A90-376 through A90-378

Mailing Address

Commander U.S. Army White Sands Missile Range Directorate of Contracting ATTN: STEWS-PR, SBIR Program Vulnerability Assessment Laboratory (VAL) White Sands Missile Range, NM 88002-5031	J. Arthur 505-678-5766

Aviation Systems Command

Topic Nos. A90-379 through A90-402

Mailing Address

Commander U.S. Army Aviation Systems Command ATTN: AMSAV-PSLZ Bldg 102, SBIR Program 4300 Goodfellow Blvd St. Louis, MO 63120-1798	R. Warhover 314-263-1082

Construction Engineering Research Laboratory

Topic Nos. A90-403 through A90-405

Mailing Address	Administrative SBIR Contact
Commander U.S. Army Construction Engineering Research Laboratory (CERL) ATTN: Chief, Procurement & Supply Branch 2909 Newmark Drive Bldg #1, Rm 175-1, SBIR Program Champaign, IL 61820-1305	D. Moody 217-373-7205

Cold Regions Research and Engineering Laboratory

Topic Nos. A90-406 and A90-407

Mailing Address

Commander U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) ATTN: CRREL-AL, SBIR Program 72 Lynne Road Hanover, NH 03755-1290	C. Martinson 603-646-4244

Engineering Topographic Laboratory

Topic Nos. A90-408 through A90-414

Mailing Address

Commander U.S. Army Engineering Topographic Laboratory (ETL) ATTN: CEETL-PR-PM, SBIR Program Bldg 2592 Ft. Belvoir, VA 22060-5546	J. Griffin 703-664-6128

Topic Nos. A90-415 through A90-416

Mailing Address

Commander U.S. Army Engineer Waterways Experiment Station (WES) ATTN: CEWES SBIR Program-CT-C (Mr. Charles Farrior) P.O. Box 631 Vicksburg, MS 39180-0631	P. Stewart 601-634-4113

Medical Research Acquisition Activity

Topic Nos. A90-417 through A90-426

Mailing Address

Commander U.S. Army Medical Research Acquisition Activity ATTN: SGRD-RMA-RC, SBIR Program Ft. Detrick, Bldg 820 Frederick, MD 21701-5014	A. Wolfe 301-663-2744

Stategic Defense Command

Topic Nos. A90-427 through A90-450

Administrative
SBIR Contact

Mailing Address

Commander   D. Satterfield
U.S. Army Strategic Defense Command   205-895-4819
ATTN: CSSD-H-CRT (Contracts Office)
P.O. Box 1500
106 Wynn Drive
Huntsville, AL 35807-3801

Army Research Institute for Behavioral and Social Sciences

Topic Nos. A90-451 through A90-456

Mailing Address

Commander   M. Drillings
U.S. Army Research Institute for Behavioral   703-274-5572
   and Social Sciences (ARI)
ATTN: PERI-BR, SBIR Program
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

Armament Research Development and ENgineering Center

Topic Nos. A90-457 through A90-475

Mailing Address

Commander   G. Magistro
U.S. Army Armament Research and Development   201-724-7349
   and Engineering Center
ATTN: SMCAR-AST
Bldg 1, SBIR Program
Picatinny Arsenal, NJ 07806-5000

Army Research Office

Topic Nos. A90-476 through A90-479

Mailing Address

Commander   W. Sander
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DEPARTMENT OF THE ARMY
FY 1990 SMALL BUSINESS INNOVATION RESEARCH TOPICS

Belvoir Research Development and Engineering Center

A90-207   TITLE: Aluminum-Lithium Extrusion Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop technology for extruding thin-walled tubes and multi-hollow plates from aluminum-lithium alloys for use in lightweight military bridging applications.

DESCRIPTION: The benefits of aluminum-lithium (Al-Li) alloys which include high strength, increased elastic modulus, and decreased density make them attractive for military bridge applications where weight savings is a prime consideration. Extensive research has been conducted by the major producers of aluminum-lithium to demonstrate physical and welding properties. Extrusion investigations have primarily focused on round bar forms. Funding constraints have prevented the major Al-Li producers from investigating extruding Al-Li in thin-walled tubing or multi-hollow shapes, shapes commonly used on military bridges.
Phase I: Design dies and develop all technology necessary for extruding multi-hollow deck plates for the Light Assault Bridge (LAB) deck and thin-walled tubes for the top and bottom chord of the Light Vehicle/Footbridge (LV/FB). Fabricate sub-scale dies and extrude multi-hollow plate and thin-walled tube samples to verify geometry and surface finish. Determine optimal preheat temperature and ram speed.
Phase II: Modify dies in accordance with results in Phase I. Fabricate full-scale dies and extrude multi-hollow deck plates for the LAB and thin-walled tubes for the LV/FB. Verify reproducibility of strength properties and geometric tolerances. Submit design details, Level II drawings, optimum manufacturing temperature and speed, and other quality control measures.

A90-208   TITLE: Design and Development of Adhesively Bonded Joints

CATEGORY: Exploratory Development

OBJECTIVE: To help us achieve our mission of getting lighter and stronger mobile bridges.

DESCRIPTION: It is hard to use adhesives because joint design is not conducive to use of adhesives. To optimize the joint so that the joint is in shear, and methods for reducing the stress concentration.
Phase I: We would like to have several candidate joint designs for tubular and flat components of bridge structures.
Phase II: (same as for Phase I)

A90-209   TITLE: Mine Detectors

CATEGORY: Basic Research or Exploratory Development

OBJECTIVE: To analytically or experimentally demonstrate the feasibility of mine detection concepts.

DESCRIPTION: The Army currently has only a hand held metallic mine detector in its inventory. There is a critical need for a capability to detect nonmetallic as well as metallic mines. The need is for hand held and vehicular mounted detectors.
Phase I: An analytical demonstration of the concept feasibility is required. A description of an experimental approach that would verify the analytical results is required.
Phase II: Experimental verification preferably in a natural environment is required.

A90-210   TITLE: Kerosene Base Fuels in Small Gasoline Engines

CATEGORY: Exploratory Development or Advanced Development

OBJECTIVE: Develop and demonstrate technology that will allow the Army to simultaneously achieve two policy goals:
    1. Use of commercial engines that are in large scale production (NOTE: This is a cost motivated goal -- lower procurement and support costs).
    2. Delivery of a single kerosene base fuel to all tactical equipment, i.e., whatever is available: JP8, JP5, DF1, DF2, DFA (NOTE: This is a cost motivated goal -- simpler fuel distribution requiring less people and equipment).

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DESCRIPTION: The Army uses engine generator sets to produce electric power for tactical uses in ratings from 1.5 kW to 200 kW. Almost all of the smaller rated sets presently in use by the Army are gasoline engine driven. These smaller sets are present in much larger quantity than our larger rated equipment. We want to simplify logistics by eliminating the need to distribute gasoline on the battlefield. Hence, we need small engines that will operate on kerosene base fuels. We also want to buy commercial equipment whenever possible, due to the savings, both the initial procurement and throughout the life cycle. Our third desire is to have high specific performance (i.e., low size and weight) necessary for tactical military use at a reasonable cost. To meet our requirements, high performance gasoline engines need to be adapted to burn diesel fuel.

Phase I: Consider various technological approaches to converting small gasoline engines to diesel fuel. Recommend the approach that is most promising in terms of meeting military requirements for small engine generator sets. Prepare plans for Phase II.

Phase II: Demonstrate the approach developed in Phase I, by converting 5 engines (of the same rating) from each of two different manufacturers, to the use of kerosene based fuel and deliver them to Belvoir RD&E Center for incorporation into engine generator set prototypes.

A90-211   TITLE: Phase Disturbing Materials for Scattering of Electromagnetic Fields

CATEGORY: Basic Research

OBJECTIVE: To develop a camouflage system that better matches targets to background terrain.

DESCRIPTION: Background terrains possess an electromagnetic phase disturbance not present in the Army's current camouflage screens. This research seeks to develop materials, suitable for use in screens, that have a greater phase disturbance than present screens.

Phase I: Development of a thin planar material capable of providing both attenuation and phase randomization of electromagnetic fields.

Phase II: Test and evaluation of Phase I materials integrated into a screen.

A90-212   TITLE: Alternatives to Reverse Osmosis for Bulk Water Purification

CATEGORY: Basic Research

OBJECTIVE: Develop a new method to purify any raw water, including seawater desalination and nuclear, biological and chemical contaminant removal.

DESCRIPTION: Currently, the Army uses water purification systems based on reverse osmosis (RO). RO is effective, but considerable energy is required to overcome the osmotic pressure of raw water. Also, elaborate pretreatment systems must be used to prolong the life of expensive RO elements. The Army desires a system that is at least as effective as RO for water purification, yet is smaller, lighter, more economical, and longer-lived than the current systems.

Phase I: Present a theory for a new water purification technique, and demonstrate its feasibility in the laboratory.

Phase II: Build a scale model and demonstrate at several seawater and freshwater sites. Technology gained from this effort will be applicable to commercial water treatment and purification.

A90-213   TITLE: Interactive Video for Deception and Camouflage Evaluation

CATEGORY: Exploratory Development

OBJECTIVE: To design and fabricate a video interactive terminal/system to evaluate different materials or construction for decoys of, and camouflage patterns on, Army equipment.

DESCRIPTION: Video simulations of camouflage patterns and deception materials could be tested to maximize their effectiveness in a variety of terrains in which the equipment might be expected to operate. The combination of video electronics and personal computers would allow the image of the test item to be inserted into a variety of standard terrains. Changes in the camouflage pattern or decoy material's colors and gloss could be made and their effec. observed.

Phase I: Demonstrate ability to insert a correctly-sized video image of the equipment (e.g. a tank) into a specific location of a background (e.g. a treeline). Then control and change target pattern parameters such as shape, co'or and gloss in the composite imagery.

Phase II: Expand on simulation capabilities, such as providing scene rotation to view the target from different perspectives.

A90-214 TITLE: Soldier's Computer, Design of Modular Architecture

CATEGORY: Advanced Development
OBJECTIVE: To design a modular architecture for a pocket size computer based on a projection of future computer component sizes.

DESCRIPTION: The "Soldier's Computer" is a program which will require a pocket size computer consisting of modules for processing, memory, digital radio, global positioning system, battery, helmet-mounted display, input device and potentially numerous other components.
This effort will require the contractor to design the modular architecture (not any of the specific modules) of a pocket size computer. The physical architecture should be based on a projection of module sizes in the 1995-2000 time frame. A configuration of modules with a total size of 1 1/2" x 3 1/2" x 7" and a weight of less than 2 lbs. would be desirable.
Weight, size and ruggedness are critical factors to the soldier. Offerors should consider proposing a fully ruggedized container into which the lightweight modules are inserted.
Some of the design factors to be considered include the data bus, materials, physical interface of modules, power distribution and conservation, dimensions, and radio antenna.
Further information on the Soldier's Computer can be obtained from U.S. Army CECOM, Advanced Systems Concepts Directorate, AMSEL-RD-ASC-S(James Schoening), Ft. Monmouth, NJ 07703-5000. Phone:(201)532-0014.
    Phase I: Conduct a study (including a projection of module sizes) and develop a conceptual approach. Submit a comprehensive proposal for Phase II.
    Phase II: Design, build and test prototypes. Note that the actual modules will not be available at this point. Define specifications of architecture.
    Phase III: It is hoped that the contractor will pursue a commercial market for this architecture, thereby making the modules commercially available to the government from multiple sources.

A90-215 TITLE: Neural Network-Based Classification Demonstration of Vehicle from Laser Radar and
                    Infrared Data

CATEGORY: Exploratory Development

OBJECTIVE: Develop methods to classify military vehicular targets using government-furnished laser radar (10.6 micron) vibrational spectra or range data, for eventual integration into an infrared/laser-radar multi-sensor.

DESCRIPTION: The Center for Night Vision & Electro-Optics has had some successes over the years in the classification of military targets, especially vehicles, by traditional image processing and statistical classification methods, using either infrared or laser radar data. However, the use of neural networks may provide better classification than traditional statistical methods, particularly when used in conjunction with both infrared imagery and laser radar vibrational spectra and range data.
    Phase I: Develop a neural network-based vehicle classifier using 10.6 micron laser radar range (i.e., 3-D) imagery or vibrational spectra.
    Phase II: Integrate laser radar and infrared classifiers to demonstrate a multi-sensor classifier showing high probability of classification and low false-alarm rate.

A90-216 TITLE: Target Classification in High Clutter Environment for MTI Radars

CATEGORY: Advanced Development

OBJECTIVE: Determine what modern advances in technology can do to improve radar signal processing in the identification of targets in high clutter environment.

DESCRIPTION: Current U.S. Army radar systems have a problem identifying targets in high clutter environment. This effort will identify advances in technology that will have a significant impact on how well future Army radars will identify targets in high clutter environment.
    Phase I: A study will be conducted to determine the impact of recent technological advances on target identification. This study will provide an outline of how technology has grown in the following areas: System noise reduction, increase in receivers

dynamic range, low radar cross section detection, improvement in A/D converter, Filter designs, and clutter suppression. In addition, techniques used to identify targets (e.g. helicopter vs. ground vehicle, track vs. wheel) will also be outlined.

Phase II: A study will be conducted to determine the impact of radar absorbing material, Radar Cross Section reduction, as well as the short dwell time impact on performance. Algorithms will be developed and incorporated in existing radar systems for Track vs. Wheel vs. Helicopter Classification.

A90-217 TITLE: Computer Virus Electronic Counter Measure (ECM)

CATEGORY: Exploratory Development

OBJECTIVE: The objective shall be to determine the potential for using "computer viruses" as an ECM technique against generic military communications systems/nets. The goal shall be to determine the feasibility of remotely introducing a virus into a system/net and analyzing its effects on various subsystem components.

DESCRIPTION: The purpose of this research shall be to investigate potential use of computer viruses to achieve traditional communications ECM effects in targeted communications systems. These effects can include data (information) disruption, denial, and deception, but other effects should also be researched such as effects on executable code in processors, memory storage management, etc. Research in effective methods or strategies to remotely introduce such viruses shall also be conducted. Efforts in this area should be focused on RF atmospheric signal transmission such as performed in tactical military data communication.

Phase I: Phase I shall analyze the feasibility of using viruses as an ECM technique. Analysis shall include validity studies of the concept, types of viruses suitable to be employed in this concept, strategies for virus injection, and analytical and/or simulated predictions of effects. Phase I shall culminate with the submission of a final report that details the above analysis and outlines a method that can validate the concept.

Phase II: Based on analysis performed under Phase I, develop a demonstration method that can validate the virus ECM concept and demonstrate various ECM techniques or strategies. Phase II shall culminate with this demonstration and a final report describing demonstration methodology, results, and analysis of effects compared with predicted effects from the Phase I effort. The final report shall also summarize or make conclusions as to the future potential of using virus ECM techniques or strategies.

A90-218 TITLE: Ada/UNIX Compatibility for Real-Time Applications

CATEGORY: Exploratory Development

OBJECTIVE: To support high performance capability (i.e. similar to bare target implementation) while running Ada on UNIX.

DESCRIPTION: Several issues have been identified related to the interoperability of UNIX with Ada. The most obvious incompatibility is that the Ada concurrency (tasking) can not be implemented efficiently using the standard UNIX concurrency (process) primitives. This forces implementations to use a single UNIX process to contain all of the tasks in an Ada program. The result is that any system service which suspends an Ada task, also suspends the entire program, effectively negating the desired goal of concurrency. Other problems have been noted, such as difficulty using Ada address clauses, interrupt entries, and accurate timing services. These features are absolutely critical for proper execution of real-time programs.

These limitations of UNIX have not caused serious concern in the past because UNIX was considered only for use as a software development environment. This has now changed with the availability of real-time implementations of UNIX that are designed to support embedded control applications. These implementations achieve response times and support for priorities that allow real-time developers the ability to use UNIX as a target environment.

Phase I: The Phase I of this project will attempt to resolve the incompatibilities between Ada and UNIX for real-time use. Specifically, an implementation of an Ada runtime that provides real-time support features will be designed for an appropriate real-time UNIX system or POSIX extension.

Phase II: The Phase II effort will produce an initial version of the real-time Ada runtime for execution on UNIX and begin preliminary (beta) application testing of the runtime. Phase III would improve the features accor ling to the experience gained from beta testing, ensure the implementation can be validated, and provide the documentation ..ecessary for a commercial product.

A90-219 TITLE: Method for Detecting Pinholes in Hermetic Coatings of Optical Fibers

CATEGORY: Exploratory Development

OBJECTIVE: Develop New on-line methods for detecting pinhole defects in hermetic optical fiber coatings. The detection should be an automatic process implemented after the hermetic coating process and prior to spooling on the draw tower take up reel.

DESCRIPTION: The hermetic coating of optical fiber prevents the degradation of fiber performance when the fiber is exposed to harsh environmental conditions. The coatings not only preserve the pristine strength of the glass but also act as a barrier to hydrogen and hydroxyl ions that can optically degrade the performance of the fiber over time. In fiber optic systems where continued high performance is required over a range of difficult operating conditions, these coatings can be invaluable. Identifying pinholes in these coatings is an important step in improving the production process of these fibers.

In Phase 1 a thorough investigation of state-of-the-art detection methods should be made. The investigation should include some type of standard by which the effectiveness of pinhole detection methods can be evaluated. Size of the pinhole, location of the pinhole, and percentage of pinholes detected should be included in this standard. Deficiencies in present pinhole detection methods should be identified and a plan for improvement should be formulated. This plan should include an implementation scheme that describes how the hardware/process will be integrated into a draw tower.

In Phase II the plan formulated in Phase I will be executed. This will include the implementation of the detection method on an actual draw tower. The performance of this new system will be evaluated as per the standards developed in Phase I and the results will be documented.

    Phase I: Produce a report that contains a survey of present pinhole detection methods, a set of standards to evaluate pinhole detection methods, and a plan to develop a new method of pinhole detection.

    Phase II: Implement the plan developed in Phase I with the outcome of producing hardware and procedures for automatic detection of pinholes in hermetic coatings of optical fibers. Emphasis is on the demonstration of this process on a fiber draw tower.

    Phase III: Transition of the process demonstrated in Phase II into an operational stage of manufacture that can be used for the everyday production of hermetically coated optical fibers.

A90-220   TITLE: Automated Quality Deficiency Report (QDR) Utilizing Commercially Available Smart Card
                Technologies

CATEGORY: Exploratory Development

OBJECTIVE: To improve life cycle software support problem reporting and problem resolution processes by utilizing microchip card technologies in lieu of paper forms for supporting large, software-driven Communications-Electronics (C-E) systems.

DESCRIPTION: Present reporting system does not supply all the technical data required by the software engineer to identify and resolve reported problems with software. A system resident technical database containing the systems' hardware and software configuration, serial numbers, revision letters, and other pertinent technical data would be created and maintained using radio frequency/identification (RF/ID) or smart card technology. When a software problem occurs, the system operator or maintenance repairman electronically reads and transfers the database information onto another smart card, manually enters his required inputs describing the software problem observed, and either forwards the card or uploads the information through an appropriate management information system for transfer to the cognizant software engineering center for resolution. Potential exists for also reporting hardware problems in a similar fashion.

    Phase I: Conduct a feasibility study to examine the various microchip concepts and technologies which could be utilized to provide a system solution with the desired capabilities. The study should address currently available off-the-shelf products and components, system costs, technical and technological risks, human factors, and ergonomic considerations. The study should also examine alternatives and define a hardware and software system solution approach to support the field reporting process.

    Phase II: Design, develop, fabricate and conduct test and evaluation activities on a prototype demonstration system to demonstrate system feasibility, utility and worthiness.

A90-221   TITLE: Artificial Intelligence (AI) for Command and Control

CATEGORY: Advanced Development

OBJECTIVE: Develop an artificial intelligence based decision aid for evaluation by Regular Army personnel in a realistic command and control testbed.

DESCRIPTION: A successful proposal must contain both detailed descriptions of the technologies on which the potential decision aid is based; and the specific Army application it is intended to serve. Examples include, but are not limited to, the following:

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a. A seamlessly integrated geographic information system and knowledge base. Such a system could be designed for one of these applications: determining and evaluating possible avenues of approach, defining optimal positions for artillery emplacements, assisting in the development of combat engineer barrier plans, properly situating signal centers, determining the best lines of communications for logistics support, structuring the best air defense network, or efficiently placing sensor systems.

b. An object oriented tactical simulator with automatic reasoning capabilities. The knowledge base for such a simulator should be populated with relevant information on Red and Blue tactics, equipment, order of battle, terrain constraints, etc. Such a simulator should be designed for realistic wargaming by G-3 staff officers.

c. A cooperative problem solving environment for command and control in a dispersed command post. Such a system must facilitate the formulation of plans and the distribution of orders based on the combined requirements of maneuver, logistics, fire support, air defense, and intelligence units. Inputs and constraints from both higher and lower echelon units must be accounted for and properly prioritized. Methods for ensuring security, accountability, and retention of command authority must be considered.

d. Pattern recognition techniques applied to: terrain analysis (geometric computing); planning (plan monitoring and explanation); or image processing (intelligent image analysis). Applications include sensor interpretation for G-2 staff, tactical plan assessment, and rank ordering of messages entering signal center.

A90-222   TITLE: Detection of Slow Speed Targets in Clutter

CATEGORY: Exploratory Development

OBJECTIVE: Determine what modern advances in technology can do to improve radar performance in detecting slow speed targets in clutter.

DESCRIPTION: Current U.S. Army radar systems have a problem detecting slow speed targets in clutter. These scanning radars were primarily built in the mid-1970's. This effort will identify advances in technology that will have a significant impact on how well future Army radars will perform against clutter. This effort will demonstrate how advance technology can be incorporated to satisfy the Army need.

Phase I: A study will be conducted to determine the key microwave radar technology advances that will improve performance in clutter. This study will provide an outline of where technology has advanced to reduce radar system noise, increase receiver dynamic range and improve clutter suppression. The product of this study will be a receiver design plan that incorporates existing technology for improved radar performance.

Phase II: This effort will consist of producing a brassboard model of the radar receiver from the design plan of Phase I. Receiver parameters will be measured and performance simulated for high clutter-signal ratio input. A report will be generated to assess the impact advance technology has for improved radar performance against clutter.

A90-223   TITLE: Electronically Scanned (E-Scan) Antenna Technology for a Lightweight Battlefield Surveillance Radar (LBSR)

CATEGORY: Advanced Development

OBJECTIVE: To develop small E-scan antenna technology for use in the LBSR program.

DESCRIPTION: The LBSR will replace the AN/PPS-5 and AN/PPS-15 man-portable personnel detection radar systems. The weight of the LBSR must be less than the current systems while its performance must be better. Current man-portable radars use manual scan which requires heavy mechanics (e.g. motor and gearing) and a large amount of power to scan the antenna. Since the LBSR has a requirement to weigh under 35 pounds and operate from battery power for long periods of time, the development of small E-scan antenna technology for it is a must.

Phase I: The first phase of this program will result in an analysis and paper design for a small E-scan antenna which will operate at x-band. The antenna must be small enough and light enough to be carried in a pack by a single man. The antenna gain shall be greater than 30 dB and the sidelobes shall be minimized. The antenna shall have the capability to scan from -45 to +45 degrees in azimuth but will not be required to scan in elevation. The azimuth and elevation beamwidths shall be 4 degrees. A final report will be due at the completion of this phase.

Phase II: The second phase of this program will result in a hardware demonstration of the antenna designed in Phase One. The demonstration will show that the antenna will meet each of the stated requirements. A final report will be due at the completion of this phase.

A90-224   TITLE: Voice Authentication/Recognition

CATEGORY: Exploratory Development

OBJECTIVE: Develop a generic UNIX shell to enable multiple verbal communications with command and control system applications, and demonstrate the feasibility for replacing input/output (I/O) devices for current applications.

DESCRIPTION: Current command and control applications use various input/output (I/O) devices such as a mouse, trackball or joystick to allow a user to interface with a computer system. It would be highly advantageous to develop a UNIX shell which allows a user to verbally communicate with the applications on the system. The shell would be required to accept inputs from various users and would, therefore, have to be able to recognize inputs from a variety of tactical personnel under severely degraded conditions. Due to the variety of currently available command and control systems, this tool should be generic enough so that it could, with minimal effort, easily replace an I/O device for current applications.

Phase I: Phase I will result in the initial development of the UNIX shell and a demonstration in which a user verbally communicates with a specific command and control application on the system.

Phase II: Phase II will extend the results of Phase I to accomplish the generic capability requirement to accept inputs from a variety of multiple users under severely degraded conditions, and demonstrate that it can reliably replace an I/O device for current command and control applications.

A90-225   TITLE: Dry Etch and Laser Ablation Methods for Processing of Infrared Detector Arrays

CATEGORY: Exploratory Development

OBJECTIVE: To develop a high-yield low cost processing technology for infrared detectors.

DESCRIPTION: Infrared detector arrays are currently manufactured primarily by conventional silicon photolithography. To improve the low yield, high cost of these devices, it is necessary to (1) reduce the number of processing steps and (2) remove the device from the potentially hazardous influences of the atmosphere. To implement (1), CCNVEO proposes the development of dry etch and/or laser ablation processes. To meet the requirements of (2), the processes must be conceived such that they will produce infrared detector arrays in the high vacuum environment of a molecular beam epitaxy (MBE) chamber.
In Phase I, feasibility studies to develop dry etch and/or laser ablation techniques for producing detector arrays on mercury cadmium telluride epitaxial layers will be conducted. These techniques must demonstrate compatibility with MBE processing environments.
In Phase II, the lowest risk processes will be optimized and tested. Testing will be accomplished by constructing vacuum processing modules, delivering them to CCNVEO, coupling them to the new CCNVEO MBE chamber, and demonstrating feasibility of the substrate-in array-out concept.

Phase I: Propose and show feasibility of new concepts for fabricating infrared detector arrays using dry etch and/or laser ablation processes.

Phase II: Optimize dry etch and/or laser ablation processing techniques to demonstrate feasibility of application in vacuum environments.

Phase III: Commercialize the process and equipment for high-yield low cost infrared focal plane arrays.

A90-226   TITLE: Low Probability of Intercept/Detection (LPI/D) Techniques

CATEGORY: Communications

OBJECTIVE: Develop a family of operational and/or technical techniques for use in covert short range and long range communications.

DESCRIPTION: This effort will support the application of emerging NSA developed TRANSEC Chips or Modules for achieving a wide range of voice or data covert communications dependent on the particular mission scenario. The resulting Low Probability of Intercept or Detection (LPI/D) capability could then be applied to host Line of Sight (LDS) VHF or UHF systems as well as Non Line of Sight (NLDS) communications systems such as SATCOM or HF systems.

Phase I: In Phase I of this effort, a family of operational and/or technical LPI/D techniques will be identified and developed to support both voice and data communications for use in short range as well as in long range tactical applications. Of particular importance in this Phase will be the actual evaluation of Breadboard/Brassboard versions of the candidate techniques against representative threat systems to categorize potential performance capabilities. This evaluation will either

develop or, more likely, use a recognized NSA system for the grading of the level LPI/D capability provided by a particular technique. Further, this grading will address the level of the threat against which the LPI/D technique was evaluated.

Phase II: In Phase II of this effort, the techniques developed earlier will be integrated into suitable host transmission systems to allow for more representative field evaluations. Further, the capability of applying the LPI/D techniques through increasingly more capable levels of Product Improvement to existing host equipments will be evaluated.

A90-227   TITLE: Application of Neural Networks to Command and Control

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this topic will be to convert state-of-the-art work that has been completed in Neural Networks to software, which can be used for information processing and decision making in a command and control operating environment.

DESCRIPTION: Command and control on the battlefield of the future -- i.e. 2000 and beyond -- will require extremely fast reaction times and the handling of vast amounts of information. In airborne operations this problem is complicated by the transition from air to land operations. Neural Networks have promise for providing significant improvements in reaction times by providing quantum leaps in the ability to quickly process information and perform decision aid tasks.

Phase I would be the development of a systemized plan and limited demonstration software for applying neural networks to the Army command and control systems.

Phase II would be the development and testing of a working system in a field environment, which could be used in Non-Development Item (NDI) hardware procured for Army command and control systems.

A90-228   TITLE: Software Reuse Tools

CATEGORY: Exploratory Development

OBJECTIVE: To develop tools and/or software metrics that will aid in the selection of reusable software assets.

DESCRIPTION: Software has become the major cost of ARMY C3I Systems when considered over the entire life cycle. The Department of Defense (DOD) mandate for the use of Ada endorses the concept of software reuse. Several factors, including non-technical factors, have contributed to the current situation where software reuse has not lived up to the expectations of the DOD. A significant problem when trying to reuse previously developed software assets is the selection of the best asset for the intended application. Current library tools focus on the insertion of components into the library and the identification of components that could meet the requirements of a new application. The objective of this proposal is to develop automated tools which will assist the reuser in the evaluation of assets provided by the search of a reuse database. The asset may be anything from the software development process, from a requirement to a piece of Ada code. Given the nature of software reuse, this is rarely an objective process, but one which increases the confidence of the users choice. This proposal tool will enhance the evaluation process and increase the confidence of the user that the best available asset was selected. Since the time required to select the reusable assets directly affects the cost saved by reuse, automated tools are required to quickly assist the reuser in the selection process.

Phase I: This is the concept validation phase. The result of Phase I will be the development of an approach for determining the usability of software assets and a description or specification of a proposed tool. The deliverable in Phase I will be a technical report describing the tool itself and the types of software assets that the tool can be used with. Demonstration software, if any, will not be deliverable.

Phase II: During Phase II, a prototype tool will be constructed. A demonstration of the prototype in operation will be required to show how the production tool will facilitate the component selection process. Software developed during phase II will be deliverable to the government for evaluation purposes only. After a government evaluation, suggestions on how to make the tool more applicable to C3I systems, may be offered for incorporation into the Phase III production quality versions.

A90-229   TITLE: Software Reuse Technology and Tools

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the Runtime environments needed to reuse software coded in Ada or other language, with respect to the need to port the Runtime environment to the user as well as the application programs.

DESCRIPTION: Software has become a major cost of Army C3I systems. The mandate to use Ada as the code language for the opportunity to reuse portions of an approved tested application program. However, this requires that the fielded systems

provide the runtime environment for which the programs were developed. The reuse of embedded machine code would be possible if the required runtime environment were embedded within the applications. Thus the original High-order application code would run on any system which provided a minimum bare-machine environment.

Phase I: Phase I will investigate the bare-machine capabilities of existing and anticipated Army tactical computers with respect to the ability to simulate or emulate the required runtime support software.

Phase II: Develop a composite application software package in Ada or C which will provide the runtime environment needed for a category of embedded Ada or C applications.

A90-230   TITLE: Development of Laser Beam Pointer

CATEGORY: Advanced Development

OBJECTIVE: Development of electro-optic or acousto-optic technology to direct/point laser beams as a substitute for mechanical gimbal assemblies.

DESCRIPTION: The U.S. Army is developing electro-optical systems that require very accurate pointing accuracies to direct laser energy. These systems now use mechanical gimbal assemblies which are heavy and expensive. We would like to evaluate the usage of electro-optical or acousto-optical techniques to direct laser energy as a substitute for these mechanical gimbal assemblies. These techniques would be used in a system that is equipped with a sensor and a processor that determines the position of an aimpoint with high accuracies (20 microradians). The sensor and processor will not be developed under this topic but will be considered to be commercially available. A one joule neodymium-YAG source at its prime and harmonically generated wavelengths can be assumed for the laser. We would like to determine the capabilities of the above techniques to direct a laser towards the aimpoints with a final pointing accuracy of less than 40 microradians (RMS 1 sigma).

Phase I: The first part of this effort will involve a complete analysis of electro-optical or acousto-optical pointing techniques to determine their performance and feasibility as beam directors.

Phase II: Upon completion of the analysis one technique will be selected, and equipment will be developed based upon the selected technique. A laboratory bench-top experiment will be set up to obtain accuracy data on the device and demonstrate the equipment.

A90-231   TITLE: Acoustic Charge Transport Technology for Electronic Counter Measure (ECM) System Applications

CATEGORY: Exploratory Development

OBJECTIVE: The objective shall be to determine and demonstrate suitable applications for Acoustic Charge Transport (ACT) devices for communications system of ECM system designs.

DESCRIPTION: Increased emphasis on non-European war time environments dictates that smaller, lighter weight and more power efficient systems are needed. While digital signal processors have high accuracy and flexibility, they are also expensive in terms of size, weight and power. Recent advances in Acoustic Charge Transport (ACT) technology have shown considerable promise for low power military applications. ACT devices combine SAW technology and CCD technology and therefore exhibit similar characteristics to today's compressive receivers. They are fabricated with GaAS material, however, and therefore analog and digital circuitry can be combined on the same chip. Since the input/output circuitry causes much of the power consumption in digital circuits and also because ACT devices are inherently low power, the potential for substantially reduced power requirements exist. This also brings the benefit of higher reliability due to reduced compone nt count. This effort shall investigate the creation and/or improvement of ACT devices to handle certain receiver functions such as signal compression, detection, correlation, programmable delay line, filtering and frequency dehopping to name a few. The reductions in size, weight and prime power should break new ground as the Army moves toward common modules for ground, air and UAV applications.

Phase I: Analyze, investigate, and perform studies of the state of ACT technology for application in communications ECM systems. Perform trade-off analysis of various approaches for integrating ACT technology into communications system ECM.

A90-232   TITLE: Application of Anisotropic Thermal Expansions in Crystalline Materials for Use in Interconnect Circuit Boards

CATEGORY: Exploratory Development

OBJECTIVE: To grow materials with desirable anisotropic thermal expansions and to process these materials into interconnect circuit boards for focal plane arrays.

DESCRIPTION: C2NVEO would like to develop a new interconnect circuit board (ICB) for infrared focal plane arrays. The proposed ICB will consist of a wafer of material (approximately 4cm X 4cm X .1cm) which exhibits anisotropic thermal expansion across its surface. The thermal expansion between 300 degrees K and 80 degrees K along one direction on the surface of the water must match silicon (-2.3E-4). Along the perpendicular direction on the surface the thermal expansion must match HgCdTe (-9.2E-4). These thermal expansion properties can be achieved by either of two methods. The first method requires finding a material whose thermal expansion matches Si along one direction in the boule and matches HgCdTe in a perpendicular direction. A wafer would then be cut in the plane of the two axes. The second method requires finding a material with thermal expansion greater than silicon in one direction and less than HgCdTe in the perpendicular direction. For this second method a wafer would be cut at the appropriate angle on the boule which would result in the desired thermal expansion across the surface. Graphite, tellurium, and boron nitride are possible materials. There are no known sources for single crystal tellurium or boron nitride.

    Phase I: Demonstrate the feasibility of growing single crystals of candidate materials (or highly oriented polycrystalline materials) and cutting and processing these materials into ICB's.

    Phase II: The candidate crystal with the optimal combination of properties and cost will be processed into ICB's. These ICB's will be demonstrated to have the desired thermal expansion properties and to be suitable for use in focal plane arrays.

    Phase III: Commercialize the growth and processing of the chosen material. The proposed ICB's will then be supplied to other government contractors.

A90-233   TITLE: Laser Detector Intensifiers

CATEGORY: Advanced Development

OBJECTIVE: Development of intensifier for use with laser detectors.

DESCRIPTION: The U.S. Army is developing electro-optical systems that are required to detect very low levels of laser energy at long ranges. One of the techniques used to detect these low levels incorporates a PIN silicon detector. This technique works well, but we would like to improve on its present performance. One way of improving its performance is to incorporate an intensifier in front of the silicon detector material. We would like to evaluate the concept of intensifying PIN silicon detectors with a microchannel place (MCP). A one joule neodymium-YAG source at its prime and harmonically generated wavelengths can be assumed for the laser.

    Phase I: The initial effort will include an in-depth analysis of the technique which will be used to predict the increase in performance of the detector along with any possible problems associated with the technique.

    Phase II: Upon completion of the analysis survey, development of a PIN silicon detector equipped with a MCP will be pursued. The PIN detector with MCP will be subjected to exhaustive testing to determine its performance parameters and to evaluate its potential.

A90-234   TITLE: Optical Modulator

CATEGORY: Exploratory Development

OBJECTIVE: To develop an efficient electro optical light modulator for use in EO/IR countermeasure systems.

DESCRIPTION: Development of a novel opto-electronic device to modulate light, particularly in the 1 to 5 micron spectral band, radiated by high temperature sources such as arc lamps and incandescent emitters. Desired characteristics are: High throughput power, low insertion loss, modulation rates from 20 to 2000 Hertz and modulation rate agility in times less than 0.1 second.

    Phase I: Demonstrate feasibility of approach through analytic procedures. Resolve materials problems/availability. Define Phase II program.

    Phase II: Construct prototype modulator(s). Set up an instrument test bed to evaluate performance. Demonstrate performance consistent with program goals.

A90-235   TITLE: Video Bandwidth Requirements for Remoted Applications

CATEGORY: Exploratory Development

OBJECTIVE: Establish a range of video frame rates (data requirements) to allow a remoted operator to confidently drive an unmanned ground vehicle and allow acquisition and tracking of moving targets while operating at only allowable (approved) frequency bands.

DESCRIPTION: The ability of a remoted driver to confidently operate an unmanned ground vehicle is dependent upon the information content available to the operator. Video compression techniques have been investigated that reduces information content of the scene through decreasing update rates or varying update rates of selected portions of an image. Initial acquisition of target would be accomplished by the operator (probably with a low video frame rate) with target tracking accomplished via real-time video. In all cases, the selected operational frequencies will be in Army approved frequency bands.
 Phase I: Correlate driving speeds with video frame rates/compression ratios (using approved frequency bands) and to establish minimal bandwidth requirements to accomplish remote driving.
 Phase II: Incorporating results of Phase I investigation, the target acquisition/tracking functions will be investigated to correlate video rates with angular tracking rate as a function of target speed. Capabilities of tracking airborne and ground vehicles will be demonstrated at various frame rates established in the initial investigation of Phase II.

A90-236   TITLE: VHSIC Application to Neural Network Systems

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the application of VHSIC High-density integrated circuit technology to large Neural Network (NN) Systems.

DESCRIPTION: Recent development in Neural Network technology demonstrates that effective application of NN technology to advanced computational requirements is dependent on the ability to produce very large connectivity networks. VHSIC technology, with up to one million gates on a single chip, can provide such connectivity.
 Phase I: Phase I work will consist of identification of specific very large Neural Networks which could be implemented using VHSIC technology, and development of a demonstrable design.
 Phase II: Phase II work will consist of fabrication and test of a hardware brassboard for one or more specific applications.

A90-237   TITLE: High Efficiency Power Combining Techniques

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this research is to develop high efficiency power combining techniques that will reduce the losses that normally occur when power amplifiers (in ECM systems) are combined to produce high output power for Electronic Warfare missions.

DESCRIPTION: Power combining is a technique used in mobile ground based stand-off ECM systems to achieve the required transmitted power to effectively jam distant communications receivers. Techniques and hardware to increase the efficiency of this power combining will improve the effectiveness of the given ECM system. This research effort should consider techniques and hardware to most efficiently combine power outputs from at least two 300 Watt power ampliers. Analysis should also include additional combining results for increased available transmit power. Research should consider requirements and limitations placed on power amplifiers, jamming waveforms, and antenna matching networks in implementing power combining approaches. Typical output connection is assumed to 50 ohm antenna impedance. The operational band of interest is 1-500 MHz. Other considerations to be considered are the military applicability of the technology approaches and the size and weight of potential designs.
 Phase I: Phase I shall analyze and determine viable power combining techniques, approaches, designs, and materials that have the best potential for achieving the objectives of this program. Trade-off analysis will result in recommendation of one or more approaches for demonstration. Simulations and/or calculation of expected results shall be presented as part of this analysis.
 Phase II: Develop feasible approaches into prototype models and demonstrate performance.

A90-238   TITLE: Fractals Applied to Synthetic Image Generation

CATEGORY: Explanatory Development

OBJECTIVE: Create realistic three dimensional background clutter descriptors which utilize minimal Random Access Memory (RAM) and disk storage requirements. These descriptors will be utilized in the generation of 3-D synthetic images. The images will be applied to various Automatic Target Recognizers (ATR) to evaluate their performance.

DESCRIPTION: Fractals are based on the repetitive character of forms in nature that are, for instance, apparent in the small canyons that become visible during an approach to the Grand Canyon, or the little falls in the vicinity of Niagara Falls. There are similarly repetitive forms in branch structures of trees.

Memory requirements are minimized because equations used to create pictures instead of final picture matrices are stored. In approach sequences the shapes are broken up into similar yet randomly distorted smaller structures originated by the same general procedure.

It is desirable to base the fractals on environmental properties instead of artistic intuition of users; therefore considerable research into the causes of the fractal structures is required.

Phase I: Compilation of a library of trees and rock formations that can act as background clutter. Pines and other formations, but not deciduous trees, lend themselves to being stored economically by fractal methods; therefore a discriminate use of fractals is to be planned.

Phase II: Analyze the environmental causes of the structures and the similarities and differences between natural and man-made objects. Phase II is to stress the physics that governs the choice, and clarify its impact on ATR performance.

A90-239   TITLE: Tactical Multi-Media Information Communication System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a viable militarized multi-media information communication system.

DESCRIPTION: Recently, intense research and development efforts have been devoted to a new system concept: multi-media information communication system (MMICS). However, the issues and significance of using a MMICS in the battlefield, have not been explored. A MMICS consists of personal computer-based intelligent terminals and an ISDN. The terminals provide processing and management capability for handling the different media: voice/text/graphics/still picture. The terminals are capable of receiving still pictures from high resolution cameras and free-hand drawing from digitizing tablets or display screens, and converting from one type of media to another (e.g. accepting voice commands and translating to text). The processing capabilities include a text editor, a graphics editor, a picture editor (cut/paste, reduce/enlarge) and a combined editor (superimpose text and graphics on picture). The management functions of the terminals include multiwindow displays, friendly I/O interfaces, and interactive ISDN communications. The network provides various types of communications services, including multi-media information exchange and desk-to-desk conferencing. An example is the distributed blackboard services, in which each conferee can view and draw graphics on the same picture displayed. Tactical utilization of these capabilities not only includes command posts using scenario pictures or terrain maps, but also field stations conducting video reconnaissance and surveillance activities.

Phase I: (a) Develop the system concept of a tactical MMICS.
(b) Identify the services capability and utilization possibilities for each of the functional   areas described in the Air Land Battle 2000 document.
Phase II: (a) Investigate the environmental, operational, and technical issues, including requirements and constraints of the system.
(b) Provide system development guidelines, design philosophies, and hardware/software/protocol architecture alternatives, which will be used as a basis for specifying a MMICS using existing   systems with modifications and a MMICS using future broadband ISDN systems.

A90-240   TITLE: Improvements in High Frequency (HF) Propagation

CATEGORY: Exploratory Development

OBJECTIVE: Automatic Selection of the Best Channel.

DESCRIPTION: HF spectrum has been used for Extended Line of Sight (ELOS) communication for many years. The communication is critically dependent on ionospheric channel. Most of the ionospheric channel models are statistical in nature and have almost reached a state where little would be gained by improving the statistical data base. This solicitation is intended for innovative concepts whereby realistic physical models can be integrated into HF propagation network. The HF network should have adaptive frequency management capability and should utilize the real time environmental data for prediction in both

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space and time. The model and the associated link management should be simple and be capable to operate in a PC type environment.

Phase I: The contractor will be required to develop his proposed approach into an advanced conceptual design for meeting the above requirements. A feasibility analysis and design shall be performed and demonstration of key concepts provided.

Phase II: Extend the results of Phase I to accomplish the capability requirement to accept inputs from a variety of sources. Demonstration of laboratory scale system.

A90-241   TITLE: Technology for Reengineering Tactical Software Systems

CATEGORY: Engineering Re-Development

OBJECTIVE: To develop tools, methodologies and/or techniques to facilitate reengineering of tactical software systems.

DESCRIPTION: Studies have shown that the maintenance phase is the single most expensive phase of a systems lifecycle costs. Factors which contribute to this expense are that many of the systems currently being maintained were written in assembly language or Fortran, and were not designed using modern software engineering principles or practices. These systems were also documented using standards which were in effect at the time of their conception. Additionally, during maintenance, enhancements to the software is often required due to the system's evolution over its lifetime.

The existence of tools, methods and techniques for quickly and efficiently reengineering these systems (i.e., producing software engineered versions in Ada) would permit these existing systems to continue to be used, evolved and maintained in a cost effective manner. Unfortunately, existing tools and techniques that purport to "reverse engineer" existing software, more often than not produce an Ada version of the Fortran or assembly language code, without reengineering or structuring the software in a software engineering sense. This results in "Adatran" code that has the appearance of Ada, but the structure and problems of Fortran code. The ability to overcome this barrier and to be capable to determining the functional and behavioral characteristics of existing software is essential to the success of quality Software Reengineering CASE Tools.

The objective of this effort is to develop tools, methodologies and techniques to assist in determining the functional and behavioral characteristics of existing tactical software systems for the purpose of reengineering these systems to enable them to be continually refined and improved.

Phase I: This phase should be a concept validation phase. The output is expected to be a report along with some demonstration software. The software does not have to be a deliverable. The report and demonstration should illustrate the viability of the approach.

Phase II: This phase should develop a functionally complete prototype version of the proposed software tool(s). The software from Phase II should be delivered for evaluation purposes.

Phase III: This phase will take the prototype along with recommendations from the evaluation, and develop a production quality Software Reengineering CASE Tool.

A90-242   TITLE: Passive and Active RF Decoy Effectivity

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this project is to develop a simulation of passive and active RF decoys. The simulation should be capable of evaluating the effectivity of decoy deployment on various Army airframes against single and multiple threats.

DESCRIPTION: The model should have the following capabilities:
   a. Single platform vs single threat decoy simulations.
   b. Single platform vs multiple threats decoy simulations.
   c. Capability to optimize parameters such as dispensing time, dispensing range and tow length for a   given decoy technique, given platform, and given threat.
   d. Simulation of active and passive decoy effectiveness for given platform and threat.

Phase I: Establish a software framework. Demonstrate effectivity for a single test case against a single specific threat radar.

Phase II: Develop full scale model to include multiple decoy techniques, multiple Army platforms and multiple threats.

Phase III: Focus tune model on specific Army/Navy/Air Force decoy projects. Phase III funding would be provided by the project office developing the decoy.

A90-243   TITLE: Digital Interface Between Multispectral Force Laydown and Multispectral Environment Generator

CATEGORY: Exploratory Development

OBJECTIVE: The Advanced Concepts Division of CECOM Center for Electronic Warfare/Reconnaisance Surveilance Target Acquisition (EW/RSTA) has a multi-spectral environment generator (MSEG) capable of simulating radar and laser sources. The MSEG currently consists of 9 RF single point sources coordinated through an RA-100 RAdar Signal Simulator and multiple laser bands. The MSEG is designed to test 1553B aircraft survivability equipment integration strategies. A variety of "blessed" multi-spectral force laydowns exist. The objective of this project is to develop software capable of cuing MSEG sources to simulate a given threat environment for a flight path through a given laydown.

DESCRIPTION: The program should have the following characteristics:

   a. Use of structured programming in the Ada language.
   b. User friendliness for changing flight paths and aircraft types. A visual real time display of the   threat
      engagement using computer graphics will be provided.
   c. Input/Output will be configured in such a manner that changes to tests can be made quickly and
economically.
   d. Software shall be easily restructured to accommodate improvements in the MSEG capabilities. Code   shall be
      well documented.
      Phase I: Establish a software framework. Recommend software and hardware purchases to supplement equipment the
government already owns. Develop a test plan for the final software product.
      Phase II: Write and test Ada code. Deliverables shall include all code and code generating programs (other than
compilers) used to develop the software. Host the product in CECOM Center for EW/RSTA's Advanced Concepts Laboratory.
      Phase III: Phase III would include modification of this software to accommodate testing on an integrated EW systems such
as LHX or modification of the software to accommodate other platforms. Sources of big business funding for phase III efforts
would include EW integration contractors.

**A90-244   TITLE: Adaptive Array Technology for Transportable Long Wavelength Ground Based Bistatic Radar
            Systems**

CATEGORY: Exploratory Development

OBJECTIVE: Development of survivable ground based bistatic radar systems for surveillance, weapon location and air defense.

DESCRIPTION: Transportable and quickly deployable bistatic long wavelength ground based array radar systems with a
ground wave mode of transmission meet Army survivability requirements, and may be applied to fulfill the Army needs for the
detection of masked moving targets, and in particular hovering helicopters. These systems must operate in an interference
environment which, in addition to ground clutter, includes deliberate sidelobe jamming, multiple narrow band 'friendly'
interference sources and natural interference phenomena such as lightening. In addition, because of the long wavelength,
transportability requirements, and field installation conditions, a rigid array may not be practical. The separate installation of
antenna elements of subarrays will yield a significant misalignment from a uniform spaced array. Distortion of the wavefront
due to propagation anomalies may also occur.
      Phase I: Adaptive array techniques need to be developed, during the Phase I program, which achieve coherent cancellation
of the sidelobe interference sources, and the best achievable target detection, under the described conditions.
      Phase II: The Phase II program will be based on acquiring recorded field test data for a validation and further
development of the developed designs.

**A90-245   TITLE: Integration of Defense Mapping Agency (DMA) Data Digital Terrain Elevation Data (DTED)
            and Digital Feature Attribute Data (DFAD) with Texture Overlays**

CATEGORY: Engineering Development

OBJECTIVE: Develop a 3-dimensional (3-D) terrain model (computer program) to generate a synthetic digital terrain map to
be used in synthetic image generation.

DESCRIPTION: Development of this computer program will enable synthesis of a 3-D terrain model with texture overlays.
The 3-D terrain model (computer program) will provide the user with the flexibility of using either DTED or DFAD from the
DMA, to produce a 3-D map or to develop a totally synthetic terrain map.
   Phase I:
      a. Develop software programs to generate a co-registered 3-D digital terrain map from DFAD and DTED.

b. Develop interpolation schemes to generate a high resolution digital terrain map (less then .5 Meters/Pixel) from low resolution DFAD and DTED.

Phase II:

a. Develop algorithms which completely synthesize the 3-D digital map similar to the DTED and DFAD maps. Develop procedures to use the generated 3-D digital terrain map for texture overlays.

b. Develop software programs to generate various realistic texture patterns which conform to currently available DFAD and Landsat maps. Develop procedures to map these texture patterns on to the 3-D digital terrain map.

A90-246   TITLE: Neural Network Sensor Fusion for Apache Escort Jammer Countermeasures System

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this project is to develop an EW situational display and countermeasures power management system based on neural networks to perform sensor fusion of avionics and electronic warfare systems. Typical avionics information may consist of aircraft speed, direction, altitude, digitized topographical maps, IFF, and aircraft position. Electronic warfare systems will include a minimum of jammer, radar warning receiver, missile detector, and the chaff/flare dispenser. Information will be communicated from the main 1553 bus controller to the EW 1553 bus. The neural network will be an embeddable module within the Apache Escort Jammer processing module interfacing with an Ada software environment.

DESCRIPTION: The neural network shall have the following capabilities:

a. The capability to better perform countermeasure management and situational awareness functions previously performed through standard knowledge-based or expert system techniques. Better performance means improved accuracy and/or increased processing speed.

b. The capability to enhance the pilot's decision-making ability in a dense threat environment.

c. The capability to improve the selection of appropriate countermeasures, reduce jammer beaconing, and the increase speed of countermeasures initiation.

Phase I: Define the inputs and outputs to the neural network. Define the neural network architecture. Define the training methodology for the neural network. If possible, emulate the neural network architecture and demonstrate it against a small test environment.

Phase II: Emulate the neural network in a manner that approaches real-time performance. Test the neural network against a good series of test cases. Modify the neural network accordingly. Interface/embed the network in a Apache Escort Jammer countermeasures management system and demonstrate the capability for improved performance.

Phase III: Implement the neural network in hardware. Big businesses involved in Electronic Warfare integration and businesses involved in the development of neural network chips constitute possible funding sources.

A90-247   TITLE: Binary and Amacronic Optics

CATEGORY: Basic Research

OBJECTIVE: The objective is to reduce the cost and increase the performance on the second generation FLIR sensors on the weapon systems to be used for aviation, air defense, and close combat (e.g., LHX, AWAS-H, Heavy Force Modernization, LSAT).

DESCRIPTION: Binary optics and Amacronic optics are terms used to describe optical elements made by microlithographic techniques that provide optical power and correction by phase differences in the optic's aperture. This technology was developed at MIT Lincoln Laboratory. The benefits of these technologies is in the case of Binary optics to reduce the cost of a FLIR sensor by $1000 (eight elements vs thirteen elements). In the case of Amacronics the improvements come in the increase of the signal to noise of the detector. In addition, the Amacronics is only the current possible approach for second generation to reduce the signature.

Phase I: Design two imagers incorporating Binary optics, one imager will be for the top hat configuration of the SADA DEWAR and the other will be for the proximal configuration of the SADA DEWAR. During this design effort consider not only the optical performance but also other system parameters such as packaging. Initiate the process for the fabrication of the candidate surfaces.

Design Amacronic optics for SADA backsided illuminated detector. Initiate the process for the fabrication of the Binary optic on the detector substrate.

Phase II: Continue the development of the binary surfaces required for both Top-Hat and Proximal cold shield approaches. Demonstrate the two developed imagers.

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Demonstrate the actual improvements of the Amacronic optic on the detector focal plane for four or more adjacent detectors. Continue the process development to cover a 960 x 4 HgCdTe array.

A90-248   TITLE: Microelectronic Display (MIDIS) Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop state-of-the-art generic microelectronic display (MIDIS) technology, mountable on printed circuit boards (PCB) via microcircuit package, to record, store, and display fault detection/isolation data and other system information.

DESCRIPTION: Advances in technology and diagnostic software permit more accurate built-in-test (BIT) at the PCB and to the component level. However, there is no effective and efficient way of sensing faults and fault location, storing the information and displaying failure and other related system data to maintenance personnel, especially once the failed PCB has been removed from its end item. The MIDIS would provide a direct view, readable nonvolatile indicator for identification/isolation of failed PCBs and components and display other relevant system data. Other applications may include prognostics monitor (e.g., green, yellow, red), event recorder (e.g., identification of redundant circuit usage/failure) and inventory/logistics system status indicator. Display devices should be low power, minimum weight/size, reliable, reusable, resettable and designed with human factor considerations.
    Phase I: Address concepts/designs/breadboards for this display technology implementation. Conduct investigations, technical analyses and trade-offs on microcontroller/memory requirements, display technologies and strategies, power, operator effectiveness versus design concepts and hardware costs, human factors, and effective architecture for hardware/software implementation. Consideration should also be given to different types of information to be displayed and a potential family of devices.
    Phase II: Prototype MIDIS components having undergone successful test and evaluation of various MIDIS applications.

A90-249   TITLE: Signal Bandwidth/Center Frequency Measurement

CATEGORY: Exploratory Development

OBJECTIVE: Develop a means to detect the presence of many simultaneous signals in a wideband IF and to determine the center frequency and bandwidth of each signal present. The output will be real time tuning commands to an adaptive channelizer.

DESCRIPTION: Modern ESM/ELINT receivers must utilize a wide instantaneous bandwidth to intercept modern radars. The present technology for obtaining the instantaneous spectrum over the IF passband consists of SAW dispersive delay lines, Bragg cells, and digital fast Fourier transforms. Programmable filters utilizing acoustic charge transport (ACT) technology exist. If a channelizer is constructed of such programmable filters, it is possible to optimally tune each filter to a signal of interest in the passband, thus overcoming many of the problems with fixed bandwidth/center frequency channels. A means is desired to extract the bandwidth/center frequency of each signal present in the wide instantaneous bandwidth in real time. This data is then to be processed to determine the signals of interest, passed to the receiver signal processor, and used to tune a set of programmable filters to process suitably delayed signals. These signals will typically consist of pulses with durations of 50 nsec to CW, bandwidths from a few hertz to spread spectrum covering several hundred megahertz, and center frequencies which can lie anywhere in the passband. Several pulses from different emitters can be present simultaneously and overlap in frequency. The equipment developed will be integrated and tested with the MEDFLI testbed under actual field test conditions. This technology will subsequently be transitioned into the next generation of ELINT/ESM receivers for the 2000 - 2010 time frame.
    Phase I: Theoretical analysis addressing the limitations of the proposed technique in terms of: Sensitivity; number of simultaneous pulses; timing analysis including the processing time required to generate/implement the required tuning commands and their duration, signal delay required, and any systematic "dead time" before a new signal could be detected; effectivity analysis in terms of signal density and characteristics which would degrade performance. This should result in a computer simulation which demonstrates the basic feasibility of the proposed approach by generating the appropriate tuning commands from a given input spectrum, and incorporates the theoretical analysis equations/results so that the computer program can be utilized as a design tool for the implementation with specific hardware in Phase II.
    Phase II: Implement the proposed technique in an IF processor which is interfaceable with the MEDFLI testbed. Three wideband IF signal channels whose phase relationship determines the angle of arrival are provided as an input. The digital output format to the MEDFLI processor is specified and consists of a pulse descriptor word for each pulse received (time of arrival, angle of arrival, frequency, modulation, pulse width, amplitude). Depending on the proposed approach and available hardware, either existing hardware may be modified, or a plug compatible IF processor developed. The system will be tested on simulator, installed on a ground based version of MEDFLI, and later flown on an airborne MEDFLI under actual field test

conditions. The technology developed and proven in Phase II will be designed into the next generation of ELINT/ESM receivers or be inserted in preplanned product improvements to existing systems.

A90-250   TITLE: Diode Pumped Dye Laser System

CATEGORY: Advanced Development

OBJECTIVE: Develop a diode pumped dye laser system.

DESCRIPTION: Conventional dye lasers are either flashlamp or laser pumped. New developments have made diode pumping of lasers attractive for military systems. The goal of this study is to determine the conditions necessary for diode pumping of dye lasers, the performance that can be obtained, and the demonstration of the system.

Phase I: A survey and complete analysis of conditions for diode pumping of dye lasers is required. Innovative designs based upon the analysis will be presented and the most promising one(s) selected for development.

Phase II: Based upon the findings of Phase I a laboratory bench-type diode pumped dye laser will be developed and demonstrated. An exhaustive analysis of the performance of the system will be made and the potential of the system assessed. The assessment should include realistic comparisons with conventionally pumped systems. A quantitative measure should result for improvements in performance output, conversion efficiency, overall system efficiency and decreases in system weight and volume.

Chemical Research Development and Engineering Center

A90-251   TITLE: Propagation of Monoclonal Antibodies by Non-Mammalian Vectors

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this project will be to investigate alternate means of the propagation of antibodies in support of point detection systems.

DESCRIPTION: At present, the propagation of monoclonal antibodies is usually conducted in vivo in mice or by in vitro mammalian cell culture techniques. These approaches are both labor intensive and expensive. The use of bacteria or other non-mammalian vectors should dramatically decrease the cost of the production of these materials, resulting in cheaper reagents for implementation into point detection systems.

Phase I: The contractor will demonstrate the growth of a government supplied monoclonal cell line in a non-mammalian vector. The antibodies generated will then be purified, characterized, and evaluated for use in immunoassay systems against conventionally prepared antibodies.

Phase II: Propagate additional types of monoclonal antibodies from such sources as the mouse, rat, and human. Antibodies produced will also be purified, characterized, and evaluated for use in immunoassay systems. A cost vs. benefit analysis will be prepared on these techniques for comparison against conventional systems.

A90-252   TITLE: Use of Polysaccharide Adhesive Infield Pathogen Detection Devices

CATEGORY: Basic Research

OBJECTIVE: To implement the use of a polysaccharide adhesive produced by marine microorganisms for use in field pathogen detection devices. Also, proof of enhanced stability and reactivity of immobilized biologies is required.

DESCRIPTION: The need for detection of threat agents from environmental samples has prompted the use and evaluation of immobilized antibodies for capture and characterization of toxins, bacteria, and bacterial products. Unfortunately, the ideal method for immobilization with retention of biologic activity has not yet been established. Chemicals currently used, such as silane compounds, glutaraldehyde, and other cross-linking agents, exhibit stable immobilization properties but result in a low percentage of reactive antibodies.

Sensitivity of detection of very small amounts of biomass is a critical element of pathogen detection from environmental samples. Therefore, optimal reactivity is essential. Recently, a naturally synthesized polysaccharide from marine bacteria showed adhesive properties strong enough to withstand underwater ocean currents. The successful use of naturally occurring adhesives for immobilization of antibodies could improve sensitivity compared to existing methods for surface capture of threat agents.

Phase I: Demonstrate the use of naturally occurring adhesive substances as immobilization agents for antibodies. Further show that more biologic reactivity is preserved by these adhesives, resulting in high sensitivity of detection, when compared to existing methods.

Phase II: Use the immobilization agent within an instrumented flow analysis design to achieve detection of 1-10 microorganisms per ml from environmental samples.

A90-253   TITLE: Alternate Low Cost Optics for Application to Infrared Chemical Detection

CATEGORY: Basic Research

OBJECTIVE: The purpose of this project is to design an infrared optical window and beamsplitter for use with a lightweight FTIR chemical detector. The use of low cost infrared transmitting materials would greatly improve the feasibility of lightweight FTIR chemical agent detectors.

DESCRIPTION: The U.S. Army Chemical Research, Development and Engineering Center (CRDEC) has recently been engaged in an extensive in-house research program to improve passive infrared chemical detection technology. This research program has focused on developing new infrared technologies to allow for the construction of small, low cost sensors to detect chemical vapors from moving platforms. During the previous two years the research program has made significant advancements in the areas of digital signal processors, digital signal processing algorithms, sampling hardware and opto-mechanical designs. The recent advancements have the potential of greatly reducing instrument costs over currently available infrared chemical detector devices. However, a significant problem remains in that the currently used optics (ZnSe and Germanium) are a significant cost (approximately $6,000 per beamsplitter) of an infrared chemical detection system. Recently, several low cost materials have been developed for use in the mid-infrared spectral region (8 to 12 microns). One of these materials is an amorphous glass composed of equal mixtures of Selenium, Arsenic, and Germanium. The properties of this material appear to offer the potential of replacement of the ZnSe optics; however, optical window components have never been constructed of this material for applications involving infrared interferometers. Another candidate infrared transmitting material is a blend of acrylic and polycarbonate polymers. It is known that an infrared bandpass filter was made of this material.

Phase I: The desired result of this investigation would be to review the technology and select a material for application to FTIR chemical detection. The contractor would specifically evaluate the transmission properties, hardness factors, tolerance to chemicals, and the range of dielectric optical coatings that can be used (e.g. Thorium Fluoride).

Phase II: After selection of a material the contractor would fabricate two infrared windows and beamsplitters for evaluation by the in-house passive IR team.

A90-254   TITLE: Low Profile Filter for Nuclear Biological Chemical (NBC) Protective Masks

CATEGORY: Exploratory Development

OBJECTIVE: Due to the growing chemical threat, the need for a low-profile/high efficiency filter is necessary. A thin, flexible, and breathable filter material is envisioned to replace the current NBC canister.

DESCRIPTION: As chemical protection levels for the Army continue to increase, the need for a high efficiency/low profile filter is apparent. The size and bulk of the existing canister is already affecting mission performance and cannot be repositioned to alleviate all interface problems. By increasing the surface area of the filtration media, a thin, flexible filter material is envisioned to substitute for the current NBC canister. This thin, flexible, and breathable filter material could serve as both the NBC filter and the protective hood.

Phase I: Specify design concepts and fabricate prototypes.

Phase II: Desired results would include production type fabrication and testing of the concepts delivered in Phase I.

A90-255   TITLE: Biogeneration of Obscurants

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate technical feasibility of biologically generating sub-micron diameter particles with aspect ratios greater than 600 to 1.

DESCRIPTION: The project is directed toward the manufacture of obscurant materials by biological processes. Direct generation is the preferred method. However, generation of material followed by another process, e.g. pyrolization, is acceptable.

Phase I: This phase will determine through literature search and laboratory generation the feasibility of producing material in gram quantities.

Phase II: This phase will generate gram quantities of the material and test optical properties in a chamber.

A90-256   TITLE: Urease-Linked Immunoassay Reagent Stability Studies

CATEGORY: Exploratory Development

OBJECTIVE: Investigate means for increasing the stability of immunoreagents used in a particular class of enzyme-linked immunoassays of interest to CRDEC. These immunoreagents include urease conjugates, avidin conjugates and biotin conjugates. Reagent activity can be measured using technology embodied in a commercially available instrument (THRESHOLD, Molecular Devices Corporation, Menlo Park, CA), described below.

DESCRIPTION: The aforementioned sensor technology is being incorporated in a detection system for the Army. Present assay methods in this detection system involve an avidin-biotin binding event to lock the analyte complex of interest onto a nitrocellulose membrane. This membrane-complex is then analyzed in a "reader" which monitors the change in pH due to a urease (present in the complex) - urea reaction. In order to be of value as a field detector, the reagents must be stable over long periods of time (i.e. 5 years) and over a wide temperature range (up to 600 degrees Centigrade). They cannot be refrigerated. A central problem, for example, is urease conjugate stability.

Phase I: The contractor will review the sensor and assay technology in question and identify the pertinent areas of concern. A systematic study of a model system urease-antibody conjugate will be conducted to assess methods to enhance its stability and maintain its activity not only during storage but also during its preparation. This phase will be a concept demonstration, primarily aimed at identifying promising avenues of approach for Phase II.

Phase II: Will be concerned with maximizing the urease-antibody conjugate preparation and storage stability to meet Army requirements. Emphasis during this phase will shift as quickly as possible to the actual urease conjugates used in Army applications. It is expected that the Phase II effort will produce protocols for optimum preparation and stable, long term, non-refrigerated storage of urease conjugates, and perhaps other associated immunological reagents, with maximum retention of enzyme and antibody activity.

A90-257   TITLE: Advanced Technology Microphone for NBC Protective Masks

CATEGORY: Exploratory Development

OBJECTIVE: To find a microphone that is smaller and lighter, and exploits more advanced technology than the unit which is currently used in the Army's Chemical/Biological Protective Masks. Implementation of an advanced technology microphone will enable mask designers to reduce mask deadspace which will enhance compatibility with weapon systems, improve intelligibility of communications and improve field of view.

DESCRIPTION: The Army seeks a smaller and lighter microphone to replace the currently implemented Dynamic Microphone. This microphone employs antique technology and is bulky in size. The advanced microphone should be designed taking into consideration that it will be used inside a protective mask. This advanced microphone would allow mask designers to reduce the space needed inside the mask as well as improve intelligibility of communications. Reducing the deadspace in the mask will enhance compatibility with weapon systems and improve field of view.

Phase I: Identify all potential candidates from microphone manufacturers.

Phase II: Development of microphones to meet Army specifications after a preliminary screening has been conducted.

A90-258   TITLE: Surface-Ionization Detection as Applied to Aerosol Mass Concentration and Aerodynamic Size Distribution Analysis

CATEGORY: Basic Research

OBJECTIVE: When the ionization potential of an atom is exceeded by the work function of a heated surface, an electron is released from the atom. This process is called surface-ionization. By using ion collectors and signal amplification, an electrical pulse is generated. Pulse height is a function of particle size and elemental composition. By suitable calibration, surface-ionization could be used to monitor the aerosol mass concentration of military smokes. Combining surface ionization detection

with a means of achieving particle size selectivity (e.g. electrostatic/aerodynamic size separation) would provide real-time aerodynamic size analysis.

Phase I: Build and calibrate a prototype surface ionization detector for the real-time analysis of aerosol mass concentration. Concentration range is 1 to 100 milligrams/cu. meter for a variety of aerosols (i.e. metallic, graphitic, and petroleum based). Work to be completed within nine months at a cost of $50K.

Phase II: Improve the sampling efficiency/response of the surface ionization prototype of Phase I. Incorporate remote readout, battery operation, and unit ruggedness into the improved prototype. Integrate surface-ionization detection into an electrostatic/aerodynamic (or equivalent) particle size classifier for aerosols. Explore commercial applications of the surface-ionization aerosol mass/size analyzer. Work to be completed in twenty-four months for $250K.

U.S. Army Missile Command

A90-259   TITLE: Development of Warheads with Dual Mission Capability

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate the technology for the development of lethal mechanisms that have dual mission capabilities: armor and fixed wing rotary aircraft.

DESCRIPTION: Commanders and troops prior to engaging the enemy frequently have incomplete intelligence data. This is especially true with respect to the types of offensive weapons to expect. For example, both armor and helicopters will be targets of opportunity in many future battles. Therefore, a warhead effective against both these targets is extremely desirable. Advantages are obvious; increased versatility, simpler logistics, and hopefully reduced cost. The Army desires to develop a technology capable of producing a weapons system and/or warhead that is effective against multiple and diverse targets. Of particular interest are sensing, fuzing, detonation, and profile considerations.

A90-260   TITLE: Model Based Synthetic Discriminant Functions for Pattern Recognition

CATEGORY: Exploratory Development

OBJECTIVE: To optimize the use of SDF's in the tactical missile environment and the target acquisition systems for fire control applications.

DESCRIPTION: Development and test of three types of Synthetic Discriminant Functions (SDF) methods on a model data base shall be evaluated for pattern recognition. Testing shall also be conducted on actual IR and TV data of the same target type. All testing shall be validated on the Sensor Signal Processing System (SSPS) facility at MICOM. Analysis of all tests on both model and actual data shall be fully documented in the final report. The data base and methodology will be provided by government to perform this work.

A90-261   TITLE: Innovative Methods of Fabricating High Performance Fiber Reinforced Composites

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate innovative composite fabrication methodology to eliminate the use of autoclaves or fiberwinder machines in the fabrication of high performance missile components.

DESCRIPTION: High-modulus high-strength fiber reinforced composite structures are presently fabricated only by companies with specialized equipment. This requires companies to make substantial investments before being able to fabricate high performance composite components. Hence, the industrial base for manufacture of composite components is small and the components are expensive. To consolidate and cure fiber reinforced composite components usually requires an autoclave and the component to be vacuum bagged. The autoclave exerts pressure on the surrounding bag and raises the temperature to either cure or melt the resin. Components, which are surfaces of revolution, also require specialized tooling because they are frequently wound as fibers or tapes on to a mandrel and cured in an oven.
This research will develop methods of fabricating high specific strength and high specific modulus fiber reinforced components which do not depend on an autoclave or a fiber winding machine.

Phase I: Develop and demonstrate innovative composite fabrication methodology. Select a material system and fabricate a test component. The high performance of material must be verified by measuring the following properties; static tension and

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compression strengths, elastic moduli, and coefficients of thermal expansion. Performance must be comparable to materials fabricated by conventional means.

Phase II: Hardware and methodology for production of components of interest to the U.S. Army must be developed. Life of components in fatigue, static loading, and thermal environments must be determined.

A90-262   TITLE: Probe for Fluctuating Temperature Measurements in Turbulent Supersonic Flows

CATEGORY: Exploratory Development

OBJECTIVE: To measure the high frequency, fluctuating components (as opposed to the mean components) of stagnation and static temperature in high Mach number, high enthalpy, multi-species flows using optical thermometry.

DESCRIPTION: There exists a need to measure the high frequency, fluctuating components (as opposed to the mean components) of density, pressure, velocity, and temperature in high Mach number, high enthalpy and multi-species flows with mixing. Non-intrusive measurements techniques are highly desirable, but even intrusive probes can improve on the state-of-the-art.

Optical thermometry offers a promising technique for the measurement of fluctuating temperature since the technique has the required sensitivity and accuracy, has no calibration problems in multi-species flows, and works well in severe environments. This effort would entail the Exploratory Development of a probe suitable for fluctuating temperature measurements.

Phase I: An optical thermometric probe would be designed to measure the fluctuating components of stagnation and static temperature in a Mach 8, 1250 K flow.

Phase II: The probe designed in Phase I would be built and assembled for testing in a government wind tunnel facility.

A90-263   TITLE: Programmable Field of Regard Optical Proximity Fuze

CATEGORY: Exploratory Development

OBJECTIVE: To provide adaptable geometry proximity fuze technology to enhance aimable warhead effectiveness.

DESCRIPTION: Adaptable geometry proximity fuze technology is required to optimize aimable warhead effectiveness in support of high performance air defense. The effective use of aimable warhead technology requires fuzing capable of:
- Adjusting look angle to compensate for different target velocities.
- Adjusting axis angle to enhance warhead aiming.
- Providing precise directional information to enhance warhead accuracy.
A fuzing concept capable of achieving these requirements is discussed in Technical Report RD-AS-89-18. The need exists for integration of this concept into a laboratory prototype for further proof-of-principle studies.

Phase I: First phase objective for proposed task is to continue conceptual analysis initiated in-house. Range equation development and signal-to-noise analysis is required to complete design of laser transmitter/receiver package and lens assembly described in TR RD-AS-89-18.

Phase II: Second phase objective for proposed effort is to design, fabricate, and deliver a prototype laser transmitter/receiver package and lens assembly capable of performing above mentioned fuzing requirements. Prototype fuze packaging should be suitable for in-house laboratory and range experiments.

A90-264   TITLE: Coherent Feed for Spatially Distributed 94 GHz Radar Antenna Array

CATEGORY: Exploratory Development

OBJECTIVE: The objective of the existing and new Millimeter Wave (MMW) Facility is to provide a reliable, cost effective, target scenario signals at 94 GHz and to be coherent to the antenna array and spatially distributed over a field of view of 60 degrees with a path length of 15 meters to the receiver.

DESCRIPTION: Conventional waveguide and space feed techniques of generating simulated target returns from radar illumination in the 94 GHz frequency region are expensive and require high power to obtain the desired ± 10 dBm ERP level at each antenna. Cost-effective concepts are needed to route phase-coherent 94 GHz radar signals, representing target or background returns, to the appropriate elements of a matrix array of antennas spaced at 12-16 milliradian intervals over a field-of-view covering a 60 degree range in azimuth and 10 degree range in elevation. Amplitude and phase weighting among a triad of antennas fed by the target signals is required to achieve the desired angle-of-arrival control. The simulated target return signals are generated at an intermediate frequency (IF) in the range 3-10 GHz and the angle-of-arrival weighting may be

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performed at either IF or 94 GHz. Proposed feed techniques should provide ±1 GHz bandwidth, 120 dB dynamic range and 1.5 degree phase control accuracy.

Phase I: Design a means of feeding a simulated radar return signal to a large field-of-view antenna matrix array for angle-of-arrival control in a hardware-in-the-loop simulation facility for evaluation of coherent 94 GHz missile guidance radars.

Phase II: Fabricate, install and demonstrate the hardware resulting from the Phase I design.

A90-265   TITLE: Joining Techniques for Full Diameter Motorcase to End Closure

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop an efficient means of joining a closure to a full diameter opening rocket motorcase made of composite material.

DESCRIPTION: Small diameter rocket motorcases are most frequently designed with one or both ends having full diameter openings in order to effectively load propellant into the motorcase. In motorcases made of composite material, this head end opening is then fitted with a closure which attaches by some mechanical means such as a pin or key joint. This is an inefficient method and results in a "beefed up" section in this area in order to react the loads through the area where fibers were cut to accommodate the pins, key, etc. A more efficient means of joining a closure to a full diameter opening motorcase is needed.

A90-266   TITLE: Development of High Performance Inertial Measurement for Hypervelocity Missile Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop an economical, small and lightweight inertial equipment that will operate in the high 1000 g's environment for hypervelocity missile applications.

DESCRIPTION: In the past, some guidance and control applications required inertial equipment to survive high-g shock in a non-operating mode before sequencing to the operational mode in a less severe environment. Requirements for inertial equipment to not only survive but operate through high-g environments are becoming more prevalent. Some applications require operation in the ±1000 g's range. For such a hostile operating environment, the instruments should be small and lightweight.

The availability of rate sensors with these physical characteristics that will operate in the 1000 g's regime appears to be the leading problem area. An exception is the ring laser gyro, whose size (miniaturized version), weight, and performance would make it an excellent candidate for high-g applications. The major current drawback is its relative high cost.

Phase I: The objective of the first phase is to develop a low cost alternate method of measuring angular rate in a high-g environment (up to 1000 g's) that does not require the use of conventional ball bearing or laser gyros and provide a basic design with supporting analysis that will establish feasibility of the proposed design.

Phase II: The objective of the second phase is to build a prototype of the rate sensor designed during Phase I and demonstrate its performance in a high-g (up to 1000 g's) environment.

A90-267   TITLE: High Speed, High Resolution Correlator

CATEGORY: Exploratory Development

OBJECTIVE: To develop a cost effective, fieldable, high speed, high resolution correlator package which is compatible of supporting frame rates required for pointing and tracking accuracies.

DESCRIPTION: High speed, high resolution correlators offer a potential solution to the background clutter and fast retargeting required for the Forward Area Air Defense (FAAD) applications. The techniques have the potential of allowing FAAD concepts to be packaged in cost effective fieldable systems as a result of improved pointing accuracies. Transputer and similar parallel processing technologies show promise in handling the large data through-puts and manipulations required to feed a central pointing and tracking system at a 300Hz to 500Hz rate. A partial frame pixel array with a minimum of 50 x 50 pixels and total grey levels as required for reliable correlations is required. Typical cameras are CCD/CID and their selection may limit or enhance the correlator capabilities.

Phase I: Design, fabricate and deliver a prototype correlator based on commercially available components such as; transputer boards, utilizing inputs from existing CID cameras and with data outputs which interface to existing central control system components. The configuration of this prototype shall be sufficient to prove the basic functional performance and low

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cost of the design. Although the prototype shall not be required to meet operational requirements of a non-cooperative target, analysis and basic algorithms shall be formulated to allow the correlator to be insensitive to size change and/or rotation.

Phase II: Design, fabricate, and deliver a fully integrated package including a high resolution camera optimized for performance at a minimum of 300Hz, with 500Hz desired and compatible with existing control systems. This package must minimize correlation problems resulting from target rotation and/or size changes during the targeting process.

A90-268   TITLE: Integral Starter/Generator for Small Turbo Jet Engines

CATEGORY: Exploratory Development

OBJECTIVE: To design, fabricate, test, and deliver a prototype starter/generator system for a missile expendable turbojet engine.

DESCRIPTION: For several current and future missile and RPV Systems a turbojet engine is an attractive propulsion system that can provide significant range increases. However, these range increases also result in increased flight times, and thus lead to increased vehicle electrical power requirements. An attractive solution is to install a direct drive shaft mounted generator on the turbojet engine to provide onboard electrical power. Such a generator would eliminate bulky thermal batteries reducing missile weight and volume. This generator could also operate as an electric motor to serve as a starter for the turbojet, thus eliminating a bulky and costly pyrotechnic start cartridge. Consequently, there exists a need to develop an integral, shaft mounted, turbojet starter/generator system. This system should be designed to operate on small turbojet engines that are up to 7.0 inches in diameter. The system shall be capable of: being integrated with existing engine designs, achieving engine starts in less than 30 seconds, and generating at least 1.0 kw of electrical power continuously for the life of the engine.

Phase I: The objective of the first phase of the proposed effort is to design, fabricate, test, and deliver a prototype starter/generator system. The prototype starter/generator shall be designed for, and integrated with, a small expendable turbojet engine (government furnished engine hardware is available). The prototype system shall be capable of starting the engine and then generating electrical power. The engine mounted starter/generator shall be a flight-weight configuration and fully integrated with the engine. Any supporting electronic controls may be produced in a breadboard configuration. The engine with integrated starter/generator and all electronic controls shall be delivered to the government for evaluation.

Phase II: The objective of the second phase of this effort is to design, fabricate, demonstrate, and deliver a fully integrated, flight-weight, flight-ready starter/generator system. This system shall consist of a turbojet engine with integral starter/generator and all associated electronic controls. This system will be completely compatible with launch vehicle and airframe integration. The contractor shall deliver one or more systems for evaluation.

U.S. Army NATICK Research Development and Engineering Center

A90-269   TITLE: Chemical Heat Sources

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to identify different chemical compounds that produce a usable exothermic output.

DESCRIPTION: Natick has developed an electrochemical heating pad for heating the Meal. Ready-to-Eat (MRE) that is called the Flameless Ration Heater. The program has been very successful and has started people thinking that perhaps other problems, including some cold weather problems, could be solved with this or some other type of chemical heater. For example, in the food area: tray packs could be heated or kept warm for extended periods, snow could be melted, and water could be heated for sanitation and beverage; in the clothing area: gloves, boots, and sleeping bags could be heated; in the medical area: patients, blood, and medical supplies could be kept warm; in the equipment area: batteries and communications equipment could be preheated in cold weather; in countersurveillance: cheap IR decoys could be deployed. Chemical reactions of substantial exothermic output need to be identified so that appropriate selections can be made to produce products with differing heat output characteristics including duration and temperature.

Phase I: Analyze different chemical reactions with a potentially useful exothermic output and identify the heat characteristics, environmental impact, potential logistics concerns, relative costs, reusable potential, physical limitations and physical hazards.

Phase II: Produce and deliver chemical heat prototype products using several chemical compounds with the greatest potential for selected military applications.

Phase III: Phase III of the program will be used to commercialize the heaters, which if successful, have considerable market potential for outdoor recreation enthusiasts.

A90-270 TITLE: Expression Systems for Fibrose Proteins

CATEGORY: Basic Research

OBJECTIVE: The development of expression systems for the efficient production of recombinant fibrous proteins in high yields.

DESCRIPTION: Protein/genetic engineering techniques are being employed to produce fibrous proteins for various material applications. Although the cloning techniques for proteins/genes are well established, the expression/synthesis of fibrous proteins in high yield with low purification costs has not been standardized. The construction of new high level protein expression systems from eukaryotic/prokaryotic systems are critical and will involve the scaling up of these systems in a commercial process to fulfill military requirements.

    Phase I: Analysis and construction of high level protein expression systems derived from eukaryotic and prokaryotic cell lines for the proteins. These expression systems should be designed to simplify gene insertion, identification and product recovery while maintaining high yields of protein and gene stability. Consideration for reducing production and purification costs should be integral with any constructed expression system.

    Phase II: Scale-up production of the desired proteins from the optimized expression systems designed in Phase I above. Yields of protein will be determined for each expression and compared to current commercial operations. Protein products will be characterized and estimates of costs for production analyzed in detail.

A90-271 TITLE: Eye Protection Against Tunable Laser Sources

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate materials and methods for reducing the intensity of all laser wavelengths from 400-1065nm.

DESCRIPTION: Eye protection against several fixed-wavelength lasers operating simultaneously in the visible and near-infrared has been feasible for some time. However, is not yet possible to provide similar protection against all wavelengths in this region of the spectrum at the same time. A system of protection is desired that will respond in the subnanonsecond time frame, to provide such protection. In the absence of laser radiation, the system should exhibit a high level of visual transmittance, high optical quality, and a wide field of view.

    Phase I: The first phase will include all work necessary to establish the soundness of the proposed approach, including demonstrations of its theoretical validity, if appropriate. In this phase, also, demonstration devices embodying the proposed protective system shall be constructed. The device should exhibit the property of attenuating any laser wavelength in the visible and near-infrared region (400-1054nm) to a significant degree, in less than a nonsecond. The potential for construction of a lightweight, headborne device, using the proposed approach, should be considered.

    Phase II: The second phase shall include further development of the technical approach demonstrated in Phase I, to optimize essential characteristics, reduce or eliminate undesirable properties, and demonstrate methods of reducing size and weight.

    The second phase shall also include construction of at least three complete goggle-type devices. These shall show improvements in operating characteristics over those exhibited in Phase I devices, in response and recovery times, field of view, optical properties, etc.

    Potential manufacturing problems to be anticipated in volume production should be discussed and addressed.

A90-272 TITLE: Diesel-Fueled Refrigeration for Nonpowered Field Kitchens

CATEGORY: Exploratory Development

OBJECTIVE: To develop a diesel-fueled heat source for commercially available heat-driven, ammonia/water cycle refrigerators.

DESCRIPTION: The current Army Field Feeding Systems (AFFS) uses ice chests to preserve perishables. This capability is subject to the availability of ice. Commercial Recreational Vehicle (RV) refrigerators operate off battery power or refined fuels (such as propane, or kerosene). Conventional diesel heat sources are either not reliable and not capable of low firing rates or require air pressure or electric power to operate. There are, however, new technologies (such as the Babington thin-film-burner) that are capable of low firing rates, smoke-free combustion, and operation with minimal electric power (such as disposable batteries or self-powered with a small thermoelectric generator).

A90-273   TITLE: Man-portable Microclimate Cooling Device Utilizing Air-Cycle Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop a lightweight, man-portable microclimate cooling device that will deliver cool, dry, filtered air to the wearer.   This device will use air-cycle technology (reverse Brayton cycle) to achieve this objective.

DESCRIPTION: There is a need to provide portable microclimate cooling to the individual soldier.   Currently, the Army is investigating vapor-compression refrigeration to meet its goals.   Air-cycle refrigeration, however, offers the opportunity for the development of a lighter-weight, less complex, portable device.   The air-cycle approach is totally compatible with the existing microclimate air vest that is currently in the Army system.   This air-cycle approach is also currently used in the M1A1 Abrams tank to supply conditioned air to each crewman.

It is desired that this lightweight microclimate backpack be capable of supplying, to the individual, 18 cubic feet/min of air with a maximum of 80 and 55 deg F, dry bulb and dew point, respectively.   The design should concentrate on energy recovery in the expansion process of the air cycle to maximize efficiency, as well as compressor and heat exchanger design.   This backpack will be powered by a heat engine utilizing a liquid fuel, gasoline or diesel (diesel preferred).   The contractor may use a heat engine of his choosing, or utilize one under development by the Army.

Phase I: of this contract should be devoted to the design of the air-cycle device, concentrating on the compressor, expander and heat exchanger, with an emphasis on minimizing weight and maximizing efficiency.   Information from Phase I should be adequate to determine the feasibility of continuing to Phase II.

Phase II: a working prototype will be constructed and demonstrated to verify design goals.

A90-274   TITLE: Dynamic Optical Camouflage Systems

CATEGORY: Basic Research

OBJECTIVE: The development of dynamic colorant systems that will be able to change color "chameleon-like" with the environment.

DESCRIPTION: Biological systems will be sought that produce pigments that have spectral properties that change with the environment or that blend with the natural environment.   Photoactivated pigments will be isolated from natural systems, characterized, and modified as necessary.   Static pigments will be sought from fungal, algal, and bacterial sources that absorb in the color ranges required for camouflage systems.   Variable pigments and organisms have been selected to carry out production, isolation, and purification procedures.   Purification and characterization of static pigment from fungi, algal, and bacteria are ongoing.

Phase I: Proof of concept, with the demonstration on a small simplified scale that color signals and color intensities from the environment can be mimicked on a flexible surface.   The colors displayed must be able to change with changes in the incoming signals, and these changes must be imaged 180 degrees from the source.

Phase II: Demonstration on a larger scale that the concept developed in Phase I above can be scaled up and is workable with different colors and intensities.   The demonstration should approach a flexible fabric as the base material.

A90-275   TITLE: Coated Fabric for Five Soldier Crew Tent

CATEGORY: Advanced Development

OBJECTIVE: Develop fabric to existing Five Soldier Crew Tent.

DESCRIPTION: The Army has a need for a new, lightweight, fire, water and weatherproof fabric for the newly developed Five Soldier Crew Tent.   The existing fabric cracks and delaminates following short term exposure.

Phase I: Determine if stated minimum requirements are feasible with current state-of-the-art techniques and materials. Determine if any trade-offs may be required to achieve the desired physical performance characteristics and provide the ramifications of each.   Propose possible commercially available materials which may possess the desired minimum requirements and determine prototype costs estimate.

Phase II: Initiate material developed program to continue exploration of promising materials with the goal of obtaining a quantity of prototype yardage to be used in actual end item test applications.

<u>U.S. Army Task-Automation Command</u>

A90-276   TITLE: <u>2D Raster to 3D Vector Modeling Utilities</u>

CATEGORY: Exploratory Development

OBJECTIVE: To develop a utility to transfer engineering drawing data back and forth between the Army DSREDS and the Intergraph CADEM System.

DESCRIPTION: Currently, any DSREDS drawing is in 2D Raster format and must be manually modeled from scratch into the Intergraph CADEM system. Similarly, drawings generated from CAD models must be plotted and then scanned or photographed into DSREDS. This forces the maintenance of two separate independent databases of much of the same data and involves excessive manpower waste and duplication of efforts.

   Phase I: Identify the requirements to achieve such a 2 way transfer and demonstrate it with a sample model/drawing chosen by TACOM.

   Phase II: Develop an automated/semi-automated utility usable by T..COM engineers to perform the transfer on a daily basis.

A90-277   TITLE: <u>Personnel Heater</u>

CATEGORY: Exploratory Development

OBJECTIVE: Design, fabrication, and testing of a personnel heater applying technology advances in heat transfer, fluid flow, and combustion.

DESCRIPTION: Presently, the Army uses two sizes of personnel heaters in tracked vehicles. The smaller one provides up to 30K BTU/Hr and the larger one up to 60K BTU/Hr. These units were designed over 40 years ago using technologies available at that time. Subsequent research in combustion, heat transfer, and fluid flow lead to significant advances in these technologies. Application of these technologies to any Army personnel heater has the potential to improve performance and reduce the size, weight and fan power requirements of these units.

   Present heaters are 8 inches in diameter and 30 inches long. The replacement heater has to fit within this envelope. On the ventilation side the back pressure is 1.3 inches of water and on the gas side the back pressure is 0.9 inches of water.

   The fuels to be used are DF1, DF2, DFA and JP8. The unit should be capable of starting and operating between temperatures of 70oF and -60oF, with the fuel at the ambient temperature.

   Phase I: Identification of the innovative emerging technologies and concept design of a complete personnel heater using these technologies. The design should also include the controls.

   Phase II: Fabrication and laboratory test of selected critical components, such as the burner with controls heater exchanger, igniter, etc. Also, fabrication of the complete heater and bench test for performance.

A90-278   TITLE: <u>Four Input Stacked Microwave Antenna</u>

CATEGORY: Exploratory Development

OBJECTIVE: This program will provide another tool for potential users of robotic system to enable them to achieve multiple vehicle control. The objective is to develop a microwave antenna which consists of four non interfering omni directional microwave antennas combined into one antenna. This antenna would be mounted on an unmanned ground vehicle and would connect directly to four microwave transmitters, without the use of a combiner, for transmitting four video signals.

DESCRIPTION: Current robotic vehicles can transmit up to four simultaneous video back to a command and control center. When one omini directional microwave antenna is mounted on the vehicle, a combiner must be used to connect four microwave transmitters to the antenna. This introduces substantial loss on each of the four video channels. The other alternative is to use four separate microwave antennas mounted far enough apart on top of the vehicle to avoid interference. Each of the four antennas would be connected to one transmitter. This would reduce loss but is not satisfactory because of little available room on the vehicle for mounting antennas. It would be desirable to have a single microwave antenna which could connect to four transmitters and transmit four video simultaneously. The antenna would be required to operate in either the 1710-1850 or 2200-2300 MHz bands.

   Phase I: In Phase I the contractor would develop a concept for a four input microwave antenna and perform testing of that concept in the laboratory. The concept and testing shall be documented in sufficient detail to allow the government to determine if it will satisfy the requirements for unmanned ground vehicles. Documentation should include projected dimensions

and gain of the antenna as well as any interference between the four transmitted signals. The contractor shall submit a final report detailing all work performed during phase one of the contract.

Phase II: In the Phase II effort, the contractor shall fabricate and test a breadboard prototype four input microwave antenna. A vehicle will be provided by the government for integrating the prototype antenna and field testing at TACOM to explore the performance capabilities of the system. The following items shall be deliverable under this effort: design drawings, test report, final report and the breadboard prototype.

A90-279   TITLE: Investigate Heat Pipe Cooling of Critical Components

CATEGORY: Exploratory Development

OBJECTIVE: Determine if the principle of the sealed "heat pipe" employing a liquid, vapor, phase change is a feasible means of lowering certain critical lubricant temperatures.

DESCRIPTION: Power steering systems, hydraulic systems, transfer cases, axle sumps are typical applications where passive radiation is often insufficient to adequately control temperature.

Phase I: Develop a suitable sealed heat pickup for immersion in an axle sump, and which conceivably could convey the vapor phase outboard for example, along the axle tubes to increase the heat rejection from the axle system, thereby lowering the critical temperature of the lubricant at the gear mesh. Measure and correlate the results.

Phase II: Explore other potential application for the principle to solve critical temperature problems. Build prototypes, and demonstrate effectiveness of the approach.

A90-280   TITLE: Multiple Purpose Robotic Vehicle Camera Platform

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design, fabricate and test a camera platform for robotic vehicles to provide either stereo vision or three camera peripheral operation. Only three cameras would be mounted on the platform with only two being used for the stereo vision mode and all three being used for the peripheral mode.

DESCRIPTION: Current robotic vehicles normally provide either stereo vision cameras or 180 degree peripheral cameras but not both. Those vehicles that do provide both, mount separate cameras for each operation which requires five video cameras. It would be desirable to have a camera platform with three cameras mounted on it that could be selected to provide either stereo vision of three camera peripheral operation. In stereo vision mode, two of the cameras would have to be automatically aligned to provide stereo images. In peripheral mode, all three cameras would be aligned to provide a three camera non overlapping peripheral view. Camera field of view should be selected to best satisfy the combination of requirements.

Phase I: In Phase I the contractor would develop a concept for a multipurpose camera platform and perform testing of that concept in the laboratory. The concept and testing shall be documented in sufficient detail to allow the government to determine if it will satisfy the requirements for unmanned ground vehicles. Documentation should include projected camera mounting locations and alignment techniques, types of cameras and projected alignment accuracies. The contractor shall submit a final report detailing all work performed during phase one of the contract.

Phase II: In the Phase II effort, the contractor shall fabricate and test a breadboard prototype multipurpose camera platform. A vehicle will be provided by the government for integrating the prototype camera platform and field testing at TACOM to explore the performance capabilities of the system. The following items shall be deliverable under this effort: design drawings, test report, final report and the breadboard prototype.

A90-281   TITLE: Intergraph Modeling Libraries

CATEGORY: Exploratory Development

OBJECTIVE: To develop standardized model libraries of commonly used components and drawing symbols to be used on the Intergraph CADEM System.

DESCRIPTION: There are no standard modeling practices for creation of commonly used parts such as nuts, bolts, bosses, etc. Parts are constructed as needed in random orientation and large duplication of effort is occurring.

Phase I: Identify standard 3D and 2D components for the CAD system, their orientation, and how they will be used (what type of libraries) in models and drawings. A demonstration of some simple examples shall be provided.

Phase II: Develop the CAD model libraries and provide a completed document containing the following information for each model: its part name, its CAD filename, a 3 view graphic picture and ISO view picture, and the components origin.

A90-282   TITLE: Combat Unity Vision Device with Modular Laser Filter

CATEGORY: Advanced Development

OBJECTIVE: To provide a combat unity vision device that provides laser protection flexibility.

DESCRIPTION: Current laser protected unity devices provide fixed laser protection: the laser protection filters are not removable or interchangeable. Future combat unity devices require removable, modular laser filters that will allow the soldier to quickly and easily change the type and level of laser protection. This modular design will allow the unity device to be continuously upgraded to protect against future laser hazards/threats.

   Phase I: Redesign an M1A1 commander's short periscope utilizing a modular laser filter design. The bonded body and top level dimensions must remain unchanged. The periscope shall be designed to meet the military specification for tank periscopes (MIL-P-62420). The replaceable section should be able to incorporate up to two laser filters.

   Provide level 1 drawings and an optical analysis of the device.

   Phase II: Construct two of the periscopes designed in Phase I, incorporating modular laser filters corresponding to a Category VIII and a Category XI filter, per MIL-F-62543. Test the periscopes in accordance with MIL-P-62420.

A90-283   TITLE: Advanced Drivers Station

CATEGORY: Engineering Development

OBJECTIVE: Develop a driver's station for the VETRONICS Crew Display Demonstrator (VCDD) capable of representing new designs for future vehicles.

DESCRIPTION: The VCDD is a research and design tool used to optimize the Soldier-Machine Interface (SMI) in new or improved combat vehicles. The VCDD currently consists of three major subsystems: computer resources, two crewstations and a controller station. The two crewstations currently represent a commander's station and a gunner's station and the driving is done from the controller's station. For best evaluation on the VCDD, a driver's station is needed that is capable of representing a wide spectrum of current or future vehicles.

   Phase I: The Phase I effort will consist of designing and building the hardware for the driver's station. The drivers station will consist of metal framework, a drivers seat, displays, touch panels and controls. This station will be capable of interfacing and working with the VCDD's current Computer Generated Imagery (CGI) system and A/D interface. A Phase II plan for advanced features and an independent CGI channel for the drivers station will be developed.

   Ph   II: The Phase II effort will consist of developing advanced features and an independent CGI channel. The advanceu features will be to incorporate new seats, controls and displays and make the station as reconfigurable as possible. The independent CGI channel will need to be compatible with the current CGI system and capable of integrating into the VCDD host computer. The effort will be completed when the driver's station along with the new CGI channel is integrated into the VCDD and demonstrated with a run configuration.

A90-284   TITLE: Advanced Displays and Controls

CATEGORY: Engineering Development

OBJECTIVE: To develop Advanced Displays and Controls for the VETRONICS Crew Display Demonstrator (VCDD) with a generic interface that will allow the VCDD to be used in development of future vehicles.

DESCRIPTION: The VCDD is a research and design tool used to optimize the Soldier-Machine Interface (SMI) in new or improved combat vehicles. The current displays and controls that exist resemble M1A1 equipment. As resemble M1A1 equipment. As new displays and controls are developed for the M1A2 (i.e. thumb cursor, flat panel displays) and other future vehicles, the VCDD will have a hard time evaluating the total system unless these controls and displays are in the VCDD. To keep up with these new designs, new displays and controls (i.e. cursor controls, mouse, track ball, form fit handles, new designs in touch panels, flat panel displays, CRT's, programmable push buttons) and a generic interface for these controls need to be integrated into the VCDD.

   Phase I: The Phase I effort will consist of the development of software and hardware to provide cursor controls on both crew stations and at the controller's station. The controls will interface with the VCDD computers and displays. A Phase II plan for integrating future controls and displays with a generic interface will also be developed.

Phase II: The Phase II effort will consist of developing and integrating new controls and displays into the crew stations (i.e. a new commander's handle, a new gunner's handle, flat-panel displays, ...). For the integration of these new devices a generic interface consisting of new hardware and software needs to be developed with the capability of connecting with cursor controls, new displays, discrete switches, programmable switches or any other future controlling devices. The effort will be completed when the generic interface is incorporated into the VCDD and is capable of responding to the inputs given by both the crew and the computer simulation control.

A90-285   TITLE: Modular Armor System and Attachment Concepts

CATEGORY: Exploratory Development

OBJECTIVE: Devise, design, and demonstrate advanced technology modular armor protection concepts and attachment systems. Design of interchangeable modular armor attachment methods.

DESCRIPTION: Future combat vehicles will employ "Modular Armor" protection systems that can be changed to meet different threat levels. Advanced armor protection units will be mounted and dismounted from the basic vehicle structure as needed. A system of advanced protection units and attachment methods will be designed and developed. This project seeks innovative modular armor concepts and attachment methods for mounting of advanced armor concepts and attachment methods for mounting of advanced armor protection units against large caliber tank fired projectiles and anti-tank missiles. The mounting and attachment hardware, as well as the rest of the vehicle structure, will have to survive the ballistic shock effects transmitted through the armor protection units. A ballistic shock effects absorption system may be required.

> Phase I - Literature and technology survey.
> - Vehicle requirements analysis, threat impact analysis.
> - Concept design and evaluations.
> Phase II: - Concept testing and demonstration.
> - Application considerations.
> - Concept development.
> - Breadboard construction and demonstrations.

A90-286   TITLE: Combat Vehicle Final Drive Monitoring for Maintenance on Demand

CATEGORY: Basic Research

OBJECTIVE: To develop an on vehicle final drive monitoring system which can be used to predict impending failure to allow final drive replacement prior to catastrophic failure which could feedback into the transmission.

DESCRIPTION: The concept of Maintenance on Demand is being used by major industries throughout a broad spectrum of applications. These applications vary from aircraft engines to large power generating equipment. The basic principle is to monitor a systems performance characteristics against known or expected performance data. As the system information deviates from this expected performance criteria, an accurate prediction of impending failure can be made. By monitoring the system, these failure predictions can be used to enable corrective maintenance action to take place prior to catastrophic failure of the system. By avoiding catastrophic failure, you avoid secondary damage and over stressing other parts in the system which have greater impact on the system than the primary failure mode.

System characteristics which have proven useful as monitoring parameters included such parameters as temperature, pressure, vibrations, stress/strain and acoustical signature. By monitoring one or more of these parameters throughout the duty cycle, they can be used in a predictive manner to prevent a catastrophic condition which would cause loss of mission capabilities of the system. It has been shown in the past that rotating machinery has unique characteristics of vibration and acoustical noise which have proven to be excellent candidates for an on vehicle systems monitoring tool.

This SBIR proposes the development of an on-board final drive monitoring system which will monitor the final drives to prevent catastrophic failure of same. This system must be rugged enough to survive in a combat vehicle environment and have a mean-time-between-failure higher than the final drive system. The monitoring system is to include the latest technology in sensors, instrumentation, artificial intelligence and expert system technology in the design criteria.

> Phase I: - Selection of best parameters to monitor to predict final drive failures.
> - Build a prototype system to monitor final drive performance.
> - Test the prototype monitoring system in vehicle to substantiate its predictive performance.
> Phase II: - To field harden the prototype final drive monitoring system design to adapt the design across a range of combat vehicles.

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- Review all current final drive designs to assess the adaptability of each design to a "standard" monitoring system design package.
- Redesign the prototype design to field harden the system.
- Install hardened units on vehicles operational at training sites to assess their durability.
- Successful completion of this SBIR project will stimulate technical innovation in the private sector.

A90-287   TITLE: Investigation of Bearing Technology

CATEGORY: Exploratory Development

OBJECTIVE: Identify and demonstrate new bearing technology and materials for High Mobility Multipurpose Wheeled Vehicles (HMMWV) U-Joints and 5-ton truck sleeve bearing applications that will provide maintenance-free service, increase durability and life in future tactical trucks.

DESCRIPTION: Emerging bearing technology and current bearing designs will be tested side by side. The prototype tests will record speeds, loads, and temperatures and identify bearing type and lubricant. The evaluation of prototype will include cost savings and maintenance improvement, bearing life. For example, this evaluation will be used to enhance the Army's knowledge of bearing reactions to harsh environments (temperature, water submersion and lubrication contaminants). The analysis of new bearing technology will lead to improved vehicle reliability and cost savings for the Army.
    Phase I: Design and fabricate a U-Joint prototype for the HMMWV vehicle and sleeve bearing prototypes for the 5-ton truck. Conduct laboratory tests to compare existing bearing designs with the prototype bearing concepts.
    Phase II: Finalize design and modify bearing prototypes. Install bearing prototypes in tactical vehicles and demonstrate the reliability of these bearings in a military application.

U.S. Army Test and Evaluation Command

A90-288   TITLE: Fiber Optic Chamber Pressure Transducer

CATEGORY: Exploratory Development

OBJECTIVE: The Phase III effort will involve manufacturing a quantity of sensors.

DESCRIPTION: It is anticipated that rapid development of electrothermal (ET) guns will lead to production testing requiring routine measurement of chamber pressures from 50,000 to 120,000 pounds per square inch. A fiber optic transducer is needed to measure high pressures in the intense electromagnetic pulse (EMP) environment of an electro-thermal gun.
    At the present time, conventional piezoelectric transducers are used for making pressure measurements in weapons systems. The transducers are optically isolated and then fed to recording instrumentation. Past attempts to develop an entirely optically based pressure transducer have been unsatisfactory.
    A transducer is needed to measure high pressure inside electro-thermal guns. The transducer must measure pressures from electro-thermal guns. The transducer must measure pressures from 50,000 to 120,000 pounds per square inch (psi) to an accuracy of ± 1% of reading. Fiber optic techniques must be used because of the large electro-magnetic pulses (EMP) present when the gun is fired. The smallest practical size possible is needed so that the transducer can be used on both large and small caliber weapons. A 10 mm by 1 metric thread is desired. The outside diameter of the transducer must be 1/2" or less and the length must not exceed 1 1/2". A configuration that is externally compatible with the KISTLER 6211 transducer would be ideal. Government owned facilities at Aberdeen Proving Ground, MD may be used on a limited basis to proof test the transducer up to 120,000 PSI.
    Phase I: This effort must provide a demonstration (proof of concept) with fiber optic hardware of the prototype transducer. Phase I should focus on new fiber optic technologies, since previous attempts to develop a fully optically based pressure transducer have been deemed unsatisfactory.
    Phase II: This effort will involve engineering development of the concept to demonstrate the required measurement accuracy and the capability to produce the transducer consistently.

A90-289   TITLE: Man-In-The-Loop Surrogate for the White Sands Air Defense Test Bed

CATEGORY: Exploratory Development

OBJECTIVE: Develop a prototype forward area air defense (FAAD) command and control (C2) surrogate node. The C2 surrogate node will provide actual air defense systems under test with the realistic interfaces that one might expect in an actual

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operational environment. The C2 surrogate node will be used during an actual test when the tactical C2 node is unavailable for the test. The surrogate node will also have the capability of receiving simulated battlefield information from a prescripted scenario, and thus enable the air defense system under test to interface with a C2 component that is subjected to both live and simulated test events.

DESCRIPTION: Design a FAAD C2 element surrogate node. The C2 element is the FAAD command and control node that receives information from a sensor or possibly another command and control node, processes the information, and disseminates it to the appropriate air defense unit. The design of the C2 element surrogate node will not require actual tactical hardware or software. However, both the hardware and software must be of sufficient fidelity so that actual air defense systems under test that are required to interface with the C2 surrogate element will perform as if interfacing and coordinating with an actual C2 element command and control node. The C2 surrogate will be designed with modifiability as a major attribute. Both the hardware and software should have the capability of being reconfigured to accommodate product improvement changes to the operational C2 element command and control node. During the design, the contractor will provide the government with any cost, risk, and trade-off analysis studies used to develop the design. The design specifications can be in the contractor's own format but must contain the essential information required by MIL-STD-490 and DOD-STD-2167.

   Phase I: Develop the specifications for the design and development of the man-in-the-loop (MITL) surrogate. The specifications shall include the system specification (A-level), the development specification (B-level), and product specification (C-level). The A, B, and C-level specifications shall be developed in accordance with the intent of MIL-STD-490 and DOD-STD-2167. The cost, risk, and utility tradeoff analysis studies shall be included in the contractor's product.

   Phase II: Develop the prototype MITL surrogate software according to the specifications developed during Phase I. The software shall be tested and demonstrated on existing MacIntosh computer equipment at WSMR. The MITLA surrogate node shall interface and be compatible with both higher and lower level FAAD nodes and with FAAD fire units.

   The method of remotely measuring yaw and spin of projectiles in-flight should easily be adaptable to similar needs where the motion of rotating or vibrating platforms is needed.

A90-290   TITLE: Improved Projectile Sensing Methods (Skyscreens)

CATEGORY: Engineering Development

OBJECTIVE: The development of projectile passage sensing devices (skyscreens) which are capable of detecting smaller/faster/more-distant projectiles with greater reliability and ease than present devices.

DESCRIPTION: The sensor is required to detect the passage of a projectile through a fixed plane in space. It is required that the device detect the passage of standard and proposed rounds reliably. The method should be capable of detecting rounds over a 40 by 40 foot area. Existing fin stabilized rounds have a round diameter of about 30 mm with velocities in excess of 4000 ft/second. Projectiles under development can be expected to include somewhat smaller sizes with some having velocities to 10,000 ft/second. Although somewhat dependent on test requirements, timing repeatability to less that 10 microseconds is generally required. Method must be capable of routine precise alignment of the sensing plane.

   Phase I: Would consist of complete analytical characterization of proposed techniques and the construction and test of breadboard prototypes of key subsystems.

   Phase II: Would consist of the design, fabrication and test of field-capable prototypes. This process would be iterated as necessary.

A90-291   TITLE: Research, Design, and Prototyping of a High Speed Aerial Cable Target Trolley

CATEGORY: Basic Research

OBJECTIVE: To conceptualize, design and prototype a self-contained high speed trolley that travels on a 16,000 foot two-point suspended single cable and provides for the moving of a suspended airborne target used in missile testing.

DESCRIPTION: The requirement exits to develop a high speed trolley that will travel on a single two inch KEVLAR (reg trade name) cable. The cable is supported by two mountain peaks and the separation between the mountain peaks is approximately 16,000 feet. The trolley must be self-contained, meaning that it has a propulsion and braking system, power, lights, instrumentation, space for user instrumentation, and provisions to attach to a tow trolley. Trolley shall self-accelerate down and along the cable to speeds up to 550 knots and maintain constant speed during the test. Braking will be applied appropriately.

Very little experience exists in this field of high speed trolleys that are used to support a target for missile testing. The contractor shall perform study and research in order to develop the basis for designing and prototyping such a trolley.

Phase I: The concept must be developed of suspending and controlling a high speed trolley on an aerial cable. The trolley must maintain neutral lift on the cable as the trolley moves down the cable at speeds of as much as 550 knots. Some of the considerations include: the attachment of the target to the high speed trolley, total control of the trolley as the trolley follows the catenary curve of the cable, and safe braking of the trolley at the end of the test, or as needed. The resulting concept will be a well documented conceptual design.

Phase II: This phase requires the investigation into ways of building an inexpensive, user-instrumentation-adaptable, repairable and controllable trolley, with subsystems, and will not emulate IR/Visual/RF/Ultraviolet signature data of an enemy aircraft in the cable sector where missiles will be fired at a target suspended below the trolley. The deliverables for this phase shall be the comprehensive documentation of the investigation into ways of building the trolley. The deliverables for this phase shall be the comprehensive documentation of the investigation into ways of building the trolley and subsystems, and detailed construction descriptions and drawing package. This design shall include the trolley and the subsystems described as the trolley, trolley suspension and traveling system, propulsion system, braking system, tow trolley attachment system, power/power distribution/lights, control, emergency control, antennas, instrumentation, and container space for user instrumentation. Areas of interest include: not emulating a enemy aircraft in the RF/IR/Ultraviolet and visual areas of electromagnetic spectrum, in the sector of test; addressing the possible flyability of the trolley and the maintenance of neutral lift; providing active control of the trolley so it does not fly; making the target and target subsystem easily removable from the trolley for transport from the test area by standard truck and trailer systems; and investigation of the suspension and traveling system for the trolley on the trolley.

A90-292 TITLE: Conceptualization, Design and Prototyping of High Velocity Simulated Airplane Targets Operating on an Aerial Cable Trolley

CATEGORY: Basic Research

OBJECTIVE: The objective will be to research ways and means, develop specifications, design and build an inexpensive, easily repairable, reusable airborne target that can be attached to an aerial-cable-supported-and-guided trolley traveling at speeds as high as 550 nautical miles per hour. This trolley-attached target must look like a full-sized enemy aircraft in terms of the infra-red, visual, ultraviolet and RF regions of the electromagnetic spectrum.

DESCRIPTION: The requirement exists to develop reusable, inexpensive, easily repairable targets the can be attached to a large aerial cable trolley at a safe distance from the trolley. This trolley will be accelerated along a cable approximately three miles long to speeds up to 550 knots. The target must be well controlled and must present minimum danger to the aerial cable. The target shall emit signature data in the Ultraviolet, Infra-red, Visual, and RF regions of the electromagnetic spectrum that emulate real enemy aircraft. Very little experience exists in this field of aircraft simulated targets that attach to cable trolleys. Research and study the current methods of design and fabrication to achieve the cost and weight constraints of the target, the size, and provide low damage and ease of repair when the target is hit.

Phase I: The concept must be developed of suspending and controlling a high speed target below an aerial-cable-supported trolley. The target must maintain neutral lift on the cable as the trolley moves down the cable at speeds of as much a 550 knots. Some of the considerations include: the attachment of the target to the high speed trolley, control of the target as the trolley follows the catenary curve of the cable, and safe release and downward ejection of the target if cable damage is imminent. The resulting concept will be a well documented conceptual design.

Phase II: This phase requires the investigation into ways of building an inexpensive, low damage, repairable and controllable trolley-suspended target with subsystems that will emulate IR/Visual/RF/Ultraviolet signature data of an enemy aircraft. The deliverables for this phase shall be the comprehensive documentation of the investigation into ways of building the target and subsystems, and detailed construction descriptions and drawing package. This design shall include the target and the subsystems described as the target to trolley suspension system, target control system, and the emergency target ejection/downward thrust system. Areas of interest include: emulating an enemy aircraft in the RF/IR/Ultraviolet and visual areas of electromagnetic spectrum; addressing the probable flyabililty of the target and the maintenance of neutral lift; providing active control of the target so it does not fly; making the target and subsystems easily removable from the trolley for transport from the test area by standard truck and trailer systems; and investigation of the suspension system for the target below the trolley.

A90-293 TITLE: Upgrading Relative Humidity Measuring Techniques

CATEGORY: Engineering Development

OBJECTIVE: The Phase III effort will involve manufacturing a quantity of sensors.

DESCRIPTION: The current method of measuring humidity levels in the chambers during temperature-humidity testing is to use a series of lithium chloride sensors in the chamber in order to measure the humidity level over the specified range of

temperature-humidity. This is necessitated because the lithium chloride sensors are manufactured for only a relatively small range of humidity per model. As a specific model sensor can only be calibrated at a single point, and a series of sensors are used in a single test, there becomes a range of accuracy rather than a single level of accuracy of measurement. The desired system is one that employs a single sensor that can be calibrated and used over the entire temperature-humidity range of a test which is 40 to 160 degrees F with humidity levels from less than 5% relative humidity (RH) to at least 98% RH.

Phase I: The Phase I effort will involve a feasibility study of the system concept design.

Phase II: This effort will initiate prototyping of a humidity measuring system for evaluation of systems accuracy, reliability, and operational ease.

A90-294   TITLE: Heat-Flux Sensor for Transient Convective Fluxes

CATEGORY: Exploratory Development

OBJECTIVE: The Phase III effort will involve manufacturing a quantity of a proven sensor with a known and experimentally verifiable time constant as a new piece of valuable instrumentation for use in live fire testing.

DESCRIPTION: A sensor is needed which responds to step change in incident convective heat flux so that 98% of steady state is reached within a time of 20 ms. It must be compact and readily attachable to body clothing for making convective heat flux measurements which could cause burn injury to military crews in compartments penetrated by munitions. The sensor may be configured to control the air stream velocity past the sensor and to prevent response to radiative flux. It must have a known and experimentally verifiable time constant.

Phase I: The Phase I study must produce a theoretical rationale and model for the design. The model must agree with the experimental results obtained for the time constant.

Phase II: The Phase II effort will involve the fabrication of a prototype sensor that can be evaluated under field conditions.

A90-295   TITLE: Artificial Intellegence (AI) Technology Classification Aid

CATEGORY: Exploratory Development

OBJECTIVE: To complete the database and update the system based on "Beta" Testing in Phase II.

DESCRIPTION: This research effort will determine the feasibility of developing a software aid to provide the technology manager and staff with the information necessary to understand, employ, or test a specific artificial intelligence (AI) model in an embedded system context. The aid will give the manager access to literature, references, programs or source code via a taxonomy of AI techniques mapped into a taxonomy of available data and knowledge base entries. The first taxonomy will establish a framework for categorizing AI disciplines and associated theories, algorithms, techniques, and methods. The second taxonomy will categorize the available data terms of theoretical descriptions, theoretical or empirical analyses, tools applications, test data, or benchmarks. AI technology covered by the first taxonomy should include expert systems robotics, vision, and natural language. The ultimate use of the aid/tool will require that the architecture selected be one that allows straightforward migration to the Ada language for production versions.

Phase I: This research effort will determine the feasibility of developing a software aid to provide the technology manager and his staff with the information necessary to understand, employ, or test a specific AI model in an embedded system context. This aid will give the manager access to literature, references, programs or source code via a taxonomy of AI techniques mapped into taxonomy of available data and knowledge base entries. The first taxonomy will establish a framework for categorizing AI disciplines and associated theories, algorithms, techniques, and methods. The second taxonomy will categorize the available data in terms of theoretical descriptions, theoretical or empirical analyses, tools applications, test data, or benchmarks. AI technology covered by the first taxonomy should include expert systems robotics, vision, and natural language. One of the products from this effort will be an estimate of the magnitude of work for a fully operational tool as well as an indication of the magnitude of the database maintenance effort. The initial tool should contain as complete a taxonomy as possible, although only sample branches may be populated in the database. The final Phase I product should include a recommendation as to which portions of the taxonomy appear closest to actual implementation. The ultimate use of the aid/tool will require that the architecture selected be one that allows straightforward migration to the Ada language for production versions.

Phase II: During this effort, the databases for one or more primary candidate technologies recommended in Phase I will be populated and maintenance initiated. The database population effort for the prototype will focus on material related to testing of specific AI models or model combinations to validate the implementation. Initial prototyping of the aid/tool is acceptable in any suitable development environment. The architecture selected will allow straightforward migration to the Ada language for production versions. The software tool will experience initial use and evaluation by a subset of Army technology managers. Some "Beta" testing would be required at this time also.

A90-296   TITLE: Detection of Depleted Uranium Penetrator Fragments

CATEGORY: Engineering Development

OBJECTIVE: Development of equipment and procedures needed to reasonably rapidly survey depleted uranium (DU) contaminated ranges and selectively detect DU fragments.

DESCRIPTION: DU is essentially natural uranium with a substantial fraction of the U235 removed. DU alloy is used in antiarmor ammunition (penetrators). The testing of the ammunition results in DU penetrators in the test range. Because of environmental and other reasons, these penetrators need to be located and removed. It is not required that a suitable detection method detect deeply buried rounds. A detection depth of 2 feet for full penetrators while maintaining reasonable search speed would be fully adequate. Complete penetrators weigh about 10 lbs, and it is desired that the method be capable of locating fragments down to about 1 lb. Precise location of DU during high speed search is not required. Because of the large potentially contaminated area, identification of large areas as being noncontaminated would greatly reduce the area requiring more detailed search.
    Phase I: Complete analytical treatment of the proposed techniques in sufficient detail to determine search speeds and detection limits of a system based on the techniques. Experimental (Laboratory or Field) demonstration of the proposed detection techniques. Preliminary system concept design for implementation of techniques.
    Phase II: Design, Fabrication and Test of (full-scale, if feasible) prototype detection system. Prototype would be capable of actual field use in order to demonstrate experimental performance on actual contaminated ranges.

A90-297   TITLE: Warhead Fragmentation Velocity and Mass Measurement

CATEGORY: Exploratory Development

OBJECTIVE: The objective of the Phase III project would be to procure and construct a warhead fragmentation velocity and mass measurement system.

DESCRIPTION: The development of increasingly complex and efficient warheads increases the requirement to accurately and quickly determine the mass, velocity, and the distribution of warhead fragments. Fragment mass typically varies from 0.5 to 3000 grains. Fragment velocity may range from 500 to 7000 feet per second depending on warhead size and configuration. Currently, fragment mass is determined by recovering the particles from fiber board panels and weighing them. Fragment velocity is determined from high speed photography. These existing measurement techniques are slow, labor intensive, and are no longer considered acceptable from the standpoint of accuracy and efficiency.
    Phase I: Phase I should incorporate a conceptual plan and a feasibility study.
    Phase II: The Phase II effort will involve further refinement of the concept and the design of a fragmentation measurement system.

A90-298   TITLE: Information Processing Utilizing a Database Computer

CATEGORY: Advanced Development

OBJECTIVE: Contract for two database computers for HELSTF.

DESCRIPTION: Data acquisition, data processing, and data management requirements at the High Energy Laser Test Facility are continuing to increase at a rate which makes meeting user requirements almost impossible with the current computer architecture. Handling of data is the overwhelming problem. Addition of a computer to the network that is designed to handle data could drastically improve the overall process.
    Phase I: The research activity would investigate the feasibility of utilizing a data base machine, as part of the overall computer architecture, to store the many signal parameters of information and to reduce the load on the current data processing equipment. The investigation would also include researching the possibility of also providing distributed base environment to minimize the problems of managing the enormous number of databases and to provide a standardized database environment.
    Phase II: Obtain a database computer, port existing data from the current system, and determine the improvement over existing methods.

A90-299   TITLE: Minimize High Energy Laser Systems or Subsystems Preparation Time

CATEGORY: Exploratory Development

OBJECTIVE: Contract which will assess and implement procedural/facility changes needed for optimization of preparation time for the mobile test support system.

DESCRIPTION: High energy laser system pretest activities characteristically take seven to eight hours on the day of test to activate, stabilize, checkout, and align supporting subsystems. The proposed study would evaluate pretest preparations and provide methods to minimize the required time.

Phase I: The research activity would investigate the feasibility of reducing total test preparation times. The investigative task would look at beam alignment activities since they consume the largest increment of system preparation time as well as other promising areas where substantial time savings could be achieved. The suggested solutions would identify changes which would range from procedural changes with minimal impact to implement to recommendations for facility changes with increased costs to implement.

Phase II: A detailed analysis of the test day alignment procedure shortening problem will be presented and recommended facility/procedural changes will be implemented to the degree possible. Any other problem area would receive similar analysis.

A90-300   TITLE: Modification to Mix Helium and Ethylene in Real Time

CATEGORY: Advanced Development

OBJECTIVE: Contract for two controllers to mix the Helium and Ethylene in real time.

DESCRIPTION: The mid-infrared advanced chemical laser uses an ethylene/helium mixture as fuel. The ethylene and helium are currently mixed in a precise ratio before a test, then stored in the run tank. This process of mixing the ethylene and helium presently takes up to several days per batch and can impact the test schedule if sufficient quantities (i.e. batches) can not be made in time to support the various tests. The proposed change would mix the ethylene and helium in the proper ratio in real time during the test. This improved method would increase the number of tests which could be performed with attendant benefits realized from an improved reimbursement rate.

Phase I: The research activity would investigate the feasibility of producing ethylene/helium mix in real time. This investigation would include locating controllers that would mix with the necessary accuracy and the effects of the thermodynamic properties of ethylene on this process.

Phase II: Provide a demonstration to the government of a ɪ⁻ototype system that will reliably mix the ethylene and helium in the proper ratio.

A90-301   TITLE: Improved Modeling of Laser Exhaust Atmospheric Diffusion

CATEGORY: Advanced Development

OBJECTIVE: Develop improved model of laser exhaust and atmospheric diffusion.

DESCRIPTION: The exhaust of the high energy chemical laser contains components that are hazardous in nature; specifically, Hydrogen Flouride (HF) and Nitrogen Tri-Floride (NF3). Presently, a meteorological model using existing condition data often predicts that a hazardous toxic corridor of excessive length will occur. Based on this prediction, laser testing is held in abeyance until the model predicts improved conditions. This significantly impacts the test schedule of the nation's only Tri-Service Laser Test Facility and incurs a significant cost to the government. The model presently used in corridor prediction is flawed in several ways and should be updated to reflect latest data on atmospheric diffusion of gases.

Phase I: The research activity would investigate the latest information pertaining to atmospheric diffusion of gases, develop computer models to predict the diffusion activity of the specific gases of concern in the laser exhaust, perform tests, and compile information which confirms the actual behavior of the specific gases, and finalize the computer model.

Phase II: Obtain necessary hardware and software to implement the use of the model and integrate it into a functional method for supporting test operations.

Ballistic Research Laboratory

A90-302   TITLE: Upscaled Self-Propagating High Temperature Synthesis (SHS)/Dynamic Compaction Processing

CATEGORY: Exploratory Development

OBJECTIVE: Determination of the potential for economically mass producing low porosity monolithic ceramic material by SHS/Dynamic Compaction in the quantities and sizes required for ballistic applications.

DESCRIPTION: Self-propagating High temperature Synthesis (SHS) is a potentially economic process for producing a wide variety of ceramic and refractory materials. Materials synthesized by this method are generally quite porous which is undesirable for applications where high structural strength is required. Thus, the SHS process has been combined with dynamic compaction processing to yield a technique for producing low porosity ceramic material. To date, the majority of this research has been conducted on a laboratory scale. This process has been optimized for the TiB2 and RiC systems to the point where economic and feasibility studies of pilot-plant processing are warranted. Such an investigation must include conversion of the laboratory process into a production process that can be conveniently upscaled by the use of readily available components, evaluation of relevant economic factors and materials evaluation of final products for assurance of quality control.

Phase I: Demonstrate the ability to apply the SHS/Dynamic Compaction technique by fabricating 4 inch diameter by 1 inch thick pieces of TiC at 95% of theoretical density and TiB2 at 98% of theoretical density. Microhardness values for those samples should be comparable with materials prepared by conventional hot pressing methods.

Phase II: Carry out scaled-up production of TiC and TiB2 samples at a rate which will allow the economic factors of full scale production to be extrapolated. Samples fabricated at this time are to be ballistically tested for further material characterization and process optimization.

A90-303   TITLE: High Performance Ultraviolet Through Infrared Optical Fiber System

CATEGORY: Exploratory Development

OBJECTIVE: Demonstration and delivery of high transmission and damage threshold, flexible and durable optical fibers to be utilized at laser wavelengths 0.193-10.6 microns for field applications.

DESCRIPTION: There exists a great need for the U.S. Army to develop optical fibers, couplers and fiber bundles for the transmission of intense laser radiation to single and multiple point locations. This system will be used for laser initiation and chemical analysis in the field. The fibers should be capable of high transmission (>50% from the source) of laser radiation (continuous through pulsed (psec) at wavelengths 0.193 through 10.6 microns through lengths greater than 10 meters. The fibers should have a very high damage threshold, be flexible but durable, and capable of withstanding >100 laser firings from a pulsed laser source or several hours of irradiation from a continuous laser source. The optical fiber diameter should not exceed 1 mm and the ends should be terminated as a flat polished surface or as a focusing lens. An electro-optic module which is capable of both programmed delivery of laser radiation through individual fibers and of integrity verification, is desirable.

Phase I: An optical fiber materials development and engineering feasibility study will be performed to determine the design parameters required to build the system. An early prototype delivered to BRL for evaluation is desired.

Phase II: Construction of a refined system will be accomplished and delivered to BRL for evaluation.

A90-304   TITLE: YAW Sensing Telemetry

CATEGORY: Exploratory Development

OBJECTIVE: To develop a method of making in-flight measurements on the motions of artillery shell and other projectiles. This method should not use optical techniques or use the Sun as a reference nor depend upon location of firing or direction of fire.

DESCRIPTION: The in-flight measurement of the yaw and spin motion of artillery shell has, for many years, been accomplished with the use of optical sensing techniques and standard radio-frequency (RF) telemetry techniques. This is called a yawsonde and uses optical sensors to sense the passage of the Sun as the projectile spins. Pulses from the sensors are telemetered to a ground receiving station using a standard frequency modulation (FM) telemetry system on the projectile. The current yawsonde can measure spin rate from 10 to over 400 RPS and can measure peak-to-peak with a resolution of 0.2 degree. The current yawsonde system, while very successful, can only be used under certain conditions. The sky has to be clear, and since the system depends upon having the sun as a reference, there is a "window in time" in which the yawsonde can operate, depending upon direction of fire, quadrant elevation and ephemeris data. This window can be quite narrow and can be restrictive at times.

What is desired is a system of measuring the yaw and spin motions of artillery shell in free flight. This system should not use the sun as a reference nor be contained by local weather conditions or depend upon firing conditions. Components mounted in the projectile have to survive a launch accelerations up to 60,000 G's. The system should have the same range and accuracy of operation as the current yawsonde and be able to be packaged in a configuration of typical nose fuze for artillery shell or smaller.

Possible candidates for sensing the motion would be single or multiple axis accelerometer or perhaps a system that involves the measurement of phase between sharp nulls in a radiation pattern.

Phase I: To determine and specify alternative methods of measuring yawing motions and spin rates of artillery and other projectiles in-flight. To provide and analysis of accuracy and resolution of proposed systems and an analysis of operation. Feasibility

of the methods are to be addresses as well as are methods of data analysis for the proposed method.

Phase II: To deliver to the government units that can be both laboratory test and flight testes to demonstrate the viability of the method of measuring yaw and spin motions of artillery shell, in the nose fuze area and be made to survive the launch conditions. There is a need to demonstrate the method over a wide range of possible motions and to demonstrate the method of data analysis required. i.e. the extraction of yaw and spin time histories from the data obtained.

The method of remotely measuring yaw and spin of projectiles in-flight should easily be adaptable to similar needs where the motion of rotating or vibrating platforms is needed.

A90-305   TITLE: Optical Techniques for Projectile Parameter Measurements in Ballistic and Full Field Ranges

CATEGORY: Exploratory Development

OBJECTIVE: To develop systems that use light for sensing motion and associated acceleration of projectiles, with the goal of measuring the yawing and spinning motion of a projectile in flight. Ultimately, projectile guidance and control will use the system. One use of a simple system is the measurement of the spin of a finned projectile in free flight.

Additionally, a detection and triggering system is needed that detects projectiles from 25mm to 250mm in diameter and at speeds from 60 to 2000 meters/second. The system must detect a projectile independent of whether its tracer is on or off.

DESCRIPTION: To enhance the capabilities of the Army's guidance and control systems on projectiles by using optical techniques, such as micro-electronics coupled to fiber-optic sensors with diode-laser light sources.

Guidance and control in fielded weapon systems relies on technology, such as accelerometers, that, although tried and true, is limited by space and operating conditions.

One initial application of the system is to replace the current method (the "spin box") of obtaining the spin of finned projectiles. The spin box contains sheets of cardboard placed such that the projectile is approximately normal to the plane the cardboard sheets form. When the projectile passes through the box, some reference structure on the projectile (a projectile fin, for instance) leaves its mark on the cardboard. The sheets are separated by a short distance so that when the projectile traverses the spin box, the reference is not lost, e.g. the fin of the projectile does not rotate enough to be confused with its neighbor. In this way, projectile spin can be measured.

This is a time consuming process: the box must be prepared for each firing; each piece of cardboard must be "read" by a person; the data transferred by hand. These disadvantages are significant.

An optical technique is desired to replace this very awkward system. The optical technique has the advantage of being non-intrusive. It requires no lengthy set-up. It has the ability to be connected directly to a data acquisition device that "reads" the data and transfers them electronically.

The system might be a series of short duration, high energy pulses of light to obtain data in two-dimensional slices. The pulses of light can be obtained from either a laser or a series of high energy flash tubes. Another approach might be to use a laser to track an intentional anomaly on the projectile. Interrogation of the resulting images might require high speed (possibly parallel) computing and the associated image processing hardware and software.

Another technique may be to use an on-board measurement system and to telemeter the information back to a ground station. This would be a direct spin-off of the system that would be used for guidance and control.

The detection and triggering system should also rely on optical techniques. It has a specific application in spark ranges that produce shadowgraphs of projectiles in free flight from which time and position can be measured accurately. Large caliber projectiles are tested regularly through these ranges. Current triggering systems consist of light emitting sensors and reflective tape; the projectile is detected by breaking the light sheet between the two. Triggering comes directly from detection, with some time delay included.

A light-sensitive film is used to photograph the projectile and its image on highly-reflective screens located on two walls at each individual station so the triggering system can not interfere with this operation. The current system is undesirable because it triggers for tracing OR non-tracing projectiles. This is a problem when the tracer intensity is inconsistent throughout the range.

The first system should be designed for use in a range that has a cross-section 10 meters by 10 meters. The detection window should be 2 meters by 2 meters, and a total of 25 systems would be needed. There are 1 meter square trenches located on the floor of the range and the triggering device should be located in this area to fully protect it from any fragment damage.

Other applications: the detection and triggering system could be used in any instance where detection of a moving object and subsequent action is required (in an elevator, for example).

Measurement of projectile motion and acceleration is akin to measuring the same on aircraft or spacecraft. It could even be applied in robotics where the need for small components is also of interest.

Phase I: Identify best techniques for obtaining on-board projectile motion and acceleration. Identify best technique for obtaining spin data. Identify and develop light sources and collection media. Perform initial spin measurements; interrogation by hand. Design of detection and triggering system.

Phase II: Develop prototype system for measuring projectile motion and acceleration. Develop interrogation equipment and techniques. Develop interface to computer resources. Perform automated or electronic data acquisition. Construct a prototype detection and triggering system.

<u>Atmospheric Science Laboratory</u>

A90-306   TITLE: <u>Airborne Detection of Gaseous Constituents</u>

CATEGORY: Exploratory Development

OBJECTIVE: Development of an airborne sensing device to detect and identify molecular off-gassing of controlled/suspicious substances.

DESCRIPTION: There is a need for information regarding the location and production of illegal substances. An airborne remote sensing system can help identify such clandestine operations.

Phase I: Design and engineer a remote sensing package for operation from an aerial platform. The system should be assembled and fully tested prior to incorporation onto an aircraft.

Phase II: Fabrication and demonstration of the optical remote sensing system in an airborne mode.

A90-307   TITLE: <u>Field Measurement of Bi-directional Energy Reflectance in Ultraviolet to Millimeter Wave (MMW) Electromagnetic Wavelengths</u>

CATEGORY: Exploratory Development

OBJECTIVE: Development of a methodology to make field measurements of bi-directional energy reflectance in ultraviolet to MMW electromagnetic wavelengths.

DESCRIPTION: The current thrust in modeling electro-optical phenomenology is toward physically based models which require, for initialization and/or validation, measurements of the multi-directional nature of the reflectance of energy from surfaces. Techniques for measurement of these parameters in certain wavelength bands (3-5 micrometers) are currently available in a laboratory setting but are neither portable nor multi-spectral.

Phase I: Develop methodology for field measurements of the hemispherical reflectance from surfaces as a function of wavelength and position on the hemisphere. Develop and/or modify existing instrumentation to provide a field portable capability to measure bi-directional reflectance in selected wavelength bands.

Phase II: Validate measurements.

A90-308   TITLE: <u>Impact of Target Shadows on Target Acquisition</u>

CATEGORY: Exploratory Development

OBJECTIVE: Development of an algorithm or methodology that can be used to include the effects of target shadows on target acquisition by devices operating at visual or near infrared wavelengths.

DESCRIPTION: Target acquisition models currently being used to develop tactical decision aids could be greatly enhanced by the inclusion of a shadow model that quantifies the effect of target shadows in the visual scene on target acquisition.

Phase I: Develop a computer model to characterize the effects of shadows on target acquisition for visual and near infrared wavelength devices. This shadow model would account for the effect of shadows due to the target and the dependent on the position of the sun and cloud cover. Such shadows can drastically change the acquisition range of a target. Some targets might be acquired at significantly larger ranges because of shadows. A model like the one being described here should transition naturally into use in a visualization scheme where a scene and target are computer drawn and shadows of targets would provide additional realism. The model should use modest amounts of computer time and space, and should use standard meteorological information and solar position as input. The existing target acquisition model already contains a module for computing the solar position from the following information: year, day of the year, time of the day, and position on earth surface.

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Phase II: Evaluate the shadow model developed in Phase I comparison to field data. Integrate shadow model into the Atmospheric Sciences Laboratory target acquisition model.

A90-309   TITLE: Impact of Scene Shadows on Target Acquisition

CATEGORY: Exploratory Development

OBJECTIVE: Development of an algorithm or methodology that can be used to include the effects of scene shadows in the environment on target acquisition by devices operating at visual and infrared wavelengths.

DESCRIPTION: Target acquisition models currently being used to develop tactical decision aids could be greatly enhanced by the inclusion of a shadow model that quantifies the effect of shadows in the scene on target acquisition.
Phase I: Develop a computer model to characterize the effects of shadows on target acquisition for visual, near infrared wavelength devices. This shadow model would account for the effect of shadows due to clouds, mountains, and other environmental factors on a scene. Such shadows can drastically change the contrast of a scene, depending upon the sun's orientation. The model should use modest amounts of computer time and space, and should use standard meteorological information and solar position as input. The existing target acquisition model already contains a module for computing the solar position from the following information: year, day of the year, time of the day, position on earth surface.
Phase II: Evaluate the shadow model developed in Phase I by comparison to field data. Integrate shadow model into the Atmospheric Sciences Laboratory target acquisition model.

A90-310   TITLE: Four Dimensional Mesoscale Nongaussian Multispectral Smoke Model

CATEGORY: Exploratory Development

OBJECTIVE: Develop a nongaussian multispectral smoke model for the simulation of diffusing obscurants in the surface and planetary boundary layers as a function of time with respect to a Lagrangian wind field.

DESCRIPTION: There is a need for a facile nongaussian diffusion model that may be used to rapidly estimate concentrations of obscurant clouds originated by various dissemination methods. The model should be capable of producing meaningful solutions on a microcomputer with one megabyte of RAM.
Phase I: Develop an algorithm with the capability of characterizing 4D smoke cloud diffusion utilizing readily available meteorological observations. The model should be compatible with and driven by terrain-influenced Lagrangian mesoscale wind model.
Phase II: Evaluation and testing of the prototype code using a variety of input observations obtained over variegated terrain, in all seasons and several climates.

A90-311   TITLE: Atmospheric Boundary Layer Stability Estimators for Urban Areas

CATEGORY: Exploratory Development

OBJECTIVE: Develop an atmospheric stability estimating methodology for urban areas that will characterize the stability spectrum as a continuous function and gracefully transition from open areas.

DESCRIPTION: There is a need for a method to replace the Pasquill Stability Categories as a turbulent typing scheme for the surface boundary layer. The Pasquill approach, which may not be appropriate in the urban environment, provides step-function estimates of stability and turbulence. As a consequence, discontinuities occur as stability increases and decreases.
Phase I: Develop an algorithm for urban areas that determines stability as a continuous function. The model should be conservative in computer time and space usage and should be written in PC-compatible form. It should use standard meteorological parameters as input.
Phase II: Evaluation and testing of a prototype code using a variety of input observations obtained over urban and open terrain types in all seasons and climates.

Electronics Technology and Devices Laboratory

A90-312   TITLE: Cathodes for High Temperature Molten Salt Lithium Batteries

CATEGORY: Exploratory Development

OBJECTIVE: Development of new cathode materials for high temperature molten salt lithium batteries.

DESCRIPTION: The U.S. Army requires high temperature rechargeable molten salt lithium batteries for pulse power applications. The formulation which presently comes closest to meeting projected power density requirements consists of a lithium alloy anode, lithium halide-alkali halide eultectric mixtures as electrolytes and iron disulfide as the cathode material. The cell is operable in the temperature range of 350-500 C. For pulse power applications, projected discharge current densities of the order of tens of amperes per square centimeter are required in the fractional second range and hundreds of amperes per square centimeter in the millisecond range.
The above goals can be furthered through the development of new cathode materials capable of delivering high power pulses with higher energy and low operating temperatures than the present system. These new cathode materials must be chemically and electrochemically stable in the molten salt cell environment. The new cathode materials will be characterized in half-cells using modern electrochemical techniques and tested in full cells for their current carrying capabilities.

Phase I: Phase I should result in one or more candidate high energy cathodes and compatible electrolytes. Validity of the cathode/electrolyte formulations should be demonstrated through voltammetry in laboratory half-cells and through preliminary studies of chemical stability.

Phase II: One of the candidates cathode/electrolyte combinations shall be explored more thoroughly. Complete cells or bipolar stacks of cells, having electrodes of at least several square centimeters in area, will be constructed and evaluated for pulse-carrying capability, rechargeability and chemical stability.

A90-313   TITLE: Quartz Resonator Aging Reduction

CATEGORY: Exploratory Development

OBJECTIVE: Develop methods for reducing the aging quartz crystal resonators.

DESCRIPTION: One of the major limitations on the performance of quartz crystal resonators is aging, i.e., the frequency change with time. One of the principal causes of aging is mass transfer due to the absorption and desorption of contamination inside the hermetically sealed resonator enclosure. Since it is not so much the contamination, as such, but the transfer of contamination which produces aging, the goal of this program is to minimize the contamination transfer rates. Past efforts aimed at reducing the effects of contamination have concentrated mainly on reducing the amount of contamination inside the enclosure via improved cleaning and ultrahigh vacuum processing techniques. This program is intended to develop novel methods of reducing the aging due to contamination transfer, by not only minimizing the amount of contamination inside the resonator enclosure but also by surface treatment methods (e.g., Langmuir-Blodgett [L-B] films) that can result in a significant reduction in mass transfer due to adsorption-desorption, without introducing new aging mechanisms (e.g., stress relief).

Phase I: Phase I will explore novel contamination control and surface treatment methods (e.g., L-B films), or a combination of the two. The method(s) shall be applied to the fabrication of precision quartz resonators. Evidence shall be obtained to show the efficacy of the method(s).

Phase II: Phase II will refine the contamination transfer reduction method(s) explored under Phase I. Laboratory-scale equipment shall be built (or purchased) for applying the method to quartz resonators. Resonators shall be fabricated with and without the method(s), and shall be evaluated to show the performance difference(s) due to the method. Aging and other analytical tests shall be performed during the evaluation.

Potential Applications/Impact: The accuracy of the crystal oscillators is directly related to the jamming resistance of communication, navigation, surveillance and identification-friend-or-foe systems (e.g., in frequency hopping systems, the higher the accuracy of the clock's oscillator, the faster can be the hopping rate). The aging of crystal oscillators also has a major effect on logistics costs (after a certain amount of aging, the oscillator must be recalibrated or replaced), on autonomy (radio silence) intervals, and on signal acquisition times.

A90-314   TITLE: Metal-Organic Chemical Vapor Deposition (MOCVD) of High Temperature Superconductors

CATEGORY: Exploratory Development

OBJECTIVE: To develop the requisite precursors and process parameters, and to control material variables necessary for the metal-organic chemical vapor deposition (MOCVD) of high quality conformal thin films of high transition temperature superconductors (HTcS).

DESCRIPTION: At present, no single method for the deposition of thin films HTcS is superior to others. If perfected, MOCVD can offer many significant advantages over current techniques including the twin advantages of conformal coverage at low temperatures. The proposed effort will address the reproducible growth by MOCVD of superconducting epitaxial films with

uniformity and compositional homogeneity. Once precursor reagents have been identified, numerical simulation of epitaxial growth, governing fluid flow, energy and species conservation equations will be solved.

Phase I: This phase will study the deposition kinetics and evaluate potential precursors for the deposition of HTcS and MOCVD. Modeling of the gas phase reaction kinetics will be performed and a preliminary reactor design will be derived from the analysis.

Phase II: Phase II will address the deposition of high quality HTcS films MOCVD. A prototype MOCVD system, incorporating recommended precursors and optimized MOCVD chamber design, will be fabricated, tested and evaluated. Thin films of HTcS will be deposited on various surfaces (flat, convex, concave, etc.).

Potential Applications/Impact: The applications for the use of high-temperature superconductors include a wide variety of military areas with a potential for high ROI, including: frequency control, infrared sensors, microwave detection, magnetic sensors, high-speed information processing, pulse power, and projectile launchers.

A90-315 TITLE: Collision Avoidance Systems for Low Flying Aircrafts

CATEGORY: Advanced and Exploratory Development

OBJECTIVE: Design and develop sensor components for determining altitude and rate of closure for a low altitude aircraft.

DESCRIPTION: The need exists for an integrated sensor that can detect altitude and rate closure for low flying aircraft. Trees, hills, and other ground clutter are of potential danger to this type of aircraft. The sensor should be able to determine distance and rate of closure. High resolution is required to discern ground clutter. The approach should utilize the latest integrated circuit technology to reduce both size, weight and cost.

Phase I: Perform study to determine the optimum design for the high resolution sensor defined earlier. Special attention should be given to component size, weight, performance and cost. This study will concentrate only on integrated sensor technology.

Phase II: Develop and demonstrate performance of components identified in Phase I study. Components will be integrated and system level performance demonstrated to verify approach.

Potential Application/Impact: For use in a collision avoidance and ground closure rate warning system on military aircraft. This system would provide pilots with a quick and accurate method for taking evasive action reducing potential loss of life and aircraft.

A90-316 TITLE: Microwave Hardware Descriptive Language (MHDL)

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and document a standardized language that captures the documentation, design and behavioral aspects of RF circuits.

DESCRIPTION: The intention of this program is to identify, investigate, and provide preliminary development of a Microwave Hardware Descriptive Language (MHDL). Various formats and language exist, such as EDIF (Electronic Design Interface Format) and VHDL (Very High Speed Integrated Circuits Hardware Descriptive Language), but none fully capture the design and behavioral aspects of microwave and millimeter wave circuits. Proposals emphasizing a MHDL that builds upon existing languages, formats or netlist is desired but not necessary.

Phase I: Proposed efforts should include a comprehensive survey of present documentation techniques, such as hardware descriptive languages, netlists, etc., and their applicability for evolution into a MHDL. The effort should identify current limitations and requirements for the extension to fully capture all aspects of a microwave circuit design. A feasibility study should be included to determine to what level of detail should a MHDL capture the design.

Phase II: A proof-of-principle prototype language, indicative of the findings, should be developed and provided for delivery. The prototype MHDL should be utilized to fully document the hierarchical and behavioral aspects of a microwave circuit and subsystem. Additional requirements pertaining to this research effort include the submission of monthly technical and financial reports, and a final technical report to be delivered with the software.

Potential Applications/Impact: A MHDL would provide a standardized manner for efficiently transporting and documenting RF designs. The logistics of all military systems would be stream lined and the system life extended; a MHDL would economize form, fit and replacement of systems as new technologies or new vendors emerge.

A90-317   TITLE: Built-In-Self-Test (BIST) for Off-The-Shelf and Application Specific Integrated Circuit (ASIC) Very Large Scale Integrated (VLSI) Designs

CATEGORY: Emerging Technologies

OBJECTIVE: To explore and develop built-in-self-test (BIST) approaches for board and system designs that employ a mixture of custom (ASIC) and non-custom (off-the-shelf) VLSI parts, both digital and analog.

DESCRIPTION: In many electronic systems designed today, a mixture of customizable devices (e.g., gate arrays, standard cell devices) and non-customizable devices (e.g., microprocessors or signal processors) are used. There will be a variable amount of circuit information available to the module and system designer necessary for designing a BIST capability, depending on the parts used. This effort should explore BIST approaches and techniques for mixed custom and non-custom circuitry to be used in module and system testability (BIST) design.

Phase I: Phase I should result in a technical report that explores different techniques/methodologies that could be used in the design of Self-Testing boards and systems that are comprised of a mixture of customizable and non-customizable components. Proof of concept demonstration of these techniques is desirable.

Phase II: For Phase II, a subset of these techniques should be developed and applied to an example sample.

Potential Applications/Impact: The impact of Self-Testing systems (and modules) will be increasing confidence of field test as well as higher levels of fault isolation. This will result in a minimum number of operational devices sent to the depot for repair. Self-Test also has a major impact in the area of operation and support. Specifically resulting in decreased Mean Time to Repair (MTTR) and a decreased amount of ATE necessary.

A90-318   TITLE: Innovative Millimeter Wave Integrated Circuit Concepts for Anti-Jam/Low Probability of Intercept, and Missile Seeker Applications

CATEGORY: Exploratory Development

OBJECTIVE: An investigatory and developmental effort directed towards the development of new integrated circuit concepts which will make millimeter-wave systems more transparent to intercept and jamming in heavy countermeasure environment.

DESCRIPTION: Presently, millimeter-wave missile seeker and submunition sensor designs use non-coherent either short pulse or continuous wave radar waveforms, which does not provide good protection against jammying and intercept. An innovative circuit concept able to generate coherent spread spectrum radar waveform and requiring only a single antenna would result in a compact counter measure resistant front-end design applicable to missile seekers and submunitions sensors. This design should also emphasize planar circuit configurations easily adaptable to millimeter wave monolithic integrated circuit techniques.

Phase I: An investigatory development of generic planar millimeter-wave integrated circuit techniques to provide coherent spread spectrum radar waveform for high resolution range/Doppler detection and target discrimination. Demonstrate functional feasibility of the circuit techniques investigated.

Phase II: Refine the spread spectrum circuit techniques developed under Phase I. Incorporate into the design anti-jam and low probability of intercept characteristics. Develop, design, and fabricate and demonstrate a functional planar front-end missile seeker possessing strong resistance to intercept and jamming.

Fire control radar communications systems requiring anti-jam and low probability of intercept capabilities. Army weapons systems requiring missile seekers and submunitions sensors capable of providing accurate angular and range resolutions for precise target discriminations in heavy countermeasures environment.

A90-319   TITLE: Image Compression Techniques

CATEGORY: Exploratory Development

OBJECTIVE: Recent developments have led to techniques for compression of image data at ratios ranging from 200 to 10,000. Applied to map, graphics, video, FLIR and radar data, these techniques can eliminate the problems inherent in storing and distributing vast amounts of visual information on the battlefield.

DESCRIPTION: This effort will study the applicability and implementation of image compression techniques for various tactical uses. In the case of maps and other graphic information, where storage capacity and recovery speed are requirements, but compression of the data need not be done in real time, high compression ratios can be achieved. For real time distribution of

image data, such as video, FLIR and radar, rapid compression algorithms will need to be developed with tradeoffs in compression ratio dictated by the distribution bandwidth.

Phase I: The first phase will study the range of U.S. Army needs for compression of data and tradeoffs in recovery for displaying the images in battlefield situations. Selection of prototype demonstrations will be made and the approaches will be determined for satisfying several representative tactical applications.

Phase II: In phase II, demonstrations of several approaches representing capability against the widest range of needs will be completed and the approaches documented for further refinement and development. The end products should be basic compression algorithms for several types of needs and a documented approach for applying such techniques to individual U.S. Army systems.

Applications include a wide variety of C^3, maintenance, logistics and training equipment which require the storage and display of large amounts of image data and presentation of this data on equipment operating under battlefield conditions.

A90-320   TITLE: Resonator Packaging Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a packaging technology for high precision resonators that retains the advantages of ceramic flatpacks but reduces their cost.

DESCRIPTION: Ceramic flatpacks have been developed for packaging the high precision quartz crystal resonators that are being developed for future C^3, navigation, IFF, and surveillance systems. Unfortunately, this packaging technology is expensive. Moreover, low yields due to failures at the sealing step have resulted in significant added costs. The high temperature sealing methods used in sealing other types of ceramic packages cannot be used because high temperatures can damage quartz resonators. A new resonator package that retains the advantages of ceramic flatpacks but which is significantly lower in cost is needed.

Phase I: Phase I will explore novel packaging methods for quartz crystal resonators. The study will consider all aspects of the influence of the package on resonator performance and cost. Prototypes of a new package that can accommodate high precision 15 mm diameter resonator plates shall be fabricated and evaluated.

Phase II: Phase II will refine the package, construct a laboratory-scale fabrication system for producing resonators in the new package, fabricate and evaluate high precision resonators enclosed in the new package, perform a study to determine the steps that will be needed to scale the system to manufacturing at least 100 "good" resonators per eight hour day, and project the yields and cost for such production rates.

Packaging of the quartz resonator is one of the major factors that determine the aging of crystal oscillators. The accuracy of crystal oscillators is directly related to the jamming resistance of communication, navigation, surveillance and identification-friend-or-foe systems (e.g., infrequency hopping systems, the higher the accuracy of the clock's oscillator, the faster can be the hopping rate). The aging of crystal oscillators also has a major effect on logistics costs (after a certain amount of aging, the oscillator must be recalibrated or replaced), on autonomy (radio silence) intervals, and on signal acquisition times.

A90-321   TITLE: Nanoelectronic Fabrication Techniques

CATEGORY: Exploratory Development

OBJECTIVE: Develop semiconductor nanoelectronic device fabrication techniques relevant to one, two and three dimensional carrier confinement.

DESCRIPTION: As semiconductor technology continues to pursue the scaling down of integrated circuits (IC) device dimensions into the nanoelectronic regime (<100 nm), new and interesting effects will emerge allowing for many new device concepts. If devices can be made using these concepts, they will be used to sense electromagnetic signals and pre-process and process information with relatively high throughput, and also will have the capacity to be integrated with high powered computational tools.

Phase I: Identify novel concepts, issues, and technology barriers to be overcome in the fabrication of nanoelectronic structures.

Phase II: Overcome the technology barriers identified in Phase I: assemble and implement an achievable, functional fabrication technique to demonstrate proof-of-principle and/or feasibility.

The goal is to achieve light weight, affordable electronic components and integrated sensors for future brilliant and autonomous munitions, weapons, and vehicles. Specific emphasis is focused on structures that will handle sensing data fusion, and decision making protocols, yet in spatial volumes as small as a missile head or even approaching the size of a bullet.

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A90-322   TITLE: Automated Multifunction Monolithic (MMIC) Wafer Probe Measurement System

CATEGORY: Advanced Development

OBJECTIVE: Develop test configuration and methodology for multiparameter on-wafer characterization of monolithic microwave integrated circuits.

DESCRIPTION: Testing of monolithic microwave integrated circuits (MMIC) remains a difficult and expensive task. Current methods require multiple and separate isolated tests to be performed. Methods to integrate multiple tests with a single die attach are required to simplify the overall test procedure. A single integrated test stand support by efficient automated test procedures and software is required to improve data management, test accuracy and reduce test time.

The test system must be very flexible to accommodate a wide variety of tests and die configurations. Testing capability should include noise, power, scattering parameters and spectral analysis. Additional capabilities for pulsed RF measurements is also desirable. Software should be highly modular, menu driven, and user friendly. Data management should take advantage of industry accepted procedures and report generation should provide for rapid visualization and selective formatting.

Phase I: Investigate test concepts and plan for integration of multifunction wafer probe test equipment and software to demonstrate an accurate and high throughput test capability for microwave monolithic circuits.

Phase II: Develop complete test capability as defined under Phase I. Demonstrate functional capabilities for automated noise, power, S-parameter, and spectral analysis. Laboratory facilities to support this effort are available.

High volume testing of monolithic microwave circuits for improved productivity and rapid insertion into U.S. Army systems. Thorough, repeatable, and accurate testing of these circuits is required for improved reliability and quality at reduced cost.

Harry Diamond Laboratory

A90-323   TITLE: Optical Generation/Control Distribution of Microwaves

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop necessary optoelectronic components to allow the generation, control and distribution of microwaves in a cost effective and high-performance fashion for applications such as phased array antennas. Examples of key limiting components for such applications include ultra-high speed optical detectors compatible with microwave integration, high-quality laser sources for heterodyne generation of microwave signals, optical manipulation of microwave signals, and satisfactory transitions to, from, or between optical waveguides.

DESCRIPTION: Implementation becomes particularly challenging at high microwave and millimeter wave frequencies. For some components, such as detectors, the potential for integration with other components, such as optical waveguides or microwave amplifiers is a key consideration.

Phase I: Identification of realistic achievable component characteristics and optimization of the trade-off of these characteristics relative to the proposed role in generation, control or distribution of microwaves. Existing technology will be cited as a sound foundation for the projection of achievable characteristics. Demonstration of key features or characteristics will be provided when available.

Phase II: Development and testing of the component with characteristics identified in Phase I. Tradeoffs of characteristics will be experimentally and theoretically explored. Optimized prototypes will be assembled and tested. Cost effective engineering will lead to a practical component prototype.

A90-324   TITLE: Improved Spatial Light Modulator

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop and test a spatial light modulator capable of advanced optical signal processing through improved transmission characteristics and/or integration with detectors, emitters, and logic circuits. Transmission characteristics having at least four levels of amplitude transmission and/or at least eight levels of phase transmission per pixel over an array size of at least 128 X 128 pixels are desired.

DESCRIPTION: Current spatial light modulator technology has limited amplitude transmission dynamic range, limited phase transmission, and no on-board processing. Improved spatial light modulators are needed to take full advantage of new optical architectures for optical computing and optical signal processing, especially target recognition, and to improve overall processing throughput.

Phase I: Spatial light modulator design and development. Phase I will include the identification of a candidate technology to obtain the objective, the design of the spatial light modulator, and the development of same to verify performance.

Phase II: Advanced development and testing. Upon successful demonstration of the technology and design as a viable spatial light modulator in Phase I, development of a prototype two-dimensional modulator will be conducted in Phase II.

A90-325 TITLE: ECM Resistant Global Positioning System (GPS) Receiver

CATEGORY: Basic Research

OBJECTIVE: To develop and test a technique for implementing Global Positioning System (GPS) satellite signal tracking on a high-dynamic platform while maintaining a high level of ECM resistance. The receiver
would have access to simulated navigation information of undetermined accuracy, such as a ballistic computer model. The technique may be implemented in hardware or software of a combination of both.

DESCRIPTION: The GPS system is inherently susceptible to ECM threats due to the extremely low power of the signals and constantly varying look angles from the receiver to the satellites. A high-dynamic platform for GPS requires a receiver with a large signal processing band to allow for a wide range of Doppler components. However, this runs contrary to traditional ECM techniques of maintaining a narrow clutter bandwidth.

Phase I: Identification of candidate technique. Phase I will include schematic design and mathematical analysis of any suitable techniques. The techniques will be ranked according to performance, complexity, cost, etc.

Phase II: Development and testing. Any techniques identified in Phase I will be breadboarded and tested.

A90-326 TITLE: Applications of Thin Film Technology to EM Shielding

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop and test cost effective EM Shielding applications of thin film coatings.

DESCRIPTION: The state-of-the-art in conductive film technology has advanced to the point where practically any material or combination of materials can be deposited from 10-3000A thick. These thicknesses are such that the readily available films are not useful for shielding purposes. Advances in thin film technology may provide reasonable alternatives to steel plates for architectural shielding applications.

Phase I: Investigate the application of multi-layer screens and coatings to the shielding of EM radiation in the frequency range from 100 kHz to 1 GHz. Also develop optically transparent films which incorporate layers of magnetic material and highly conductive metals.

Phase II: Test and characterize the broadband rf shielding properties of such thin films. Characterize the cost breakdown and cost effectiveness (compared to current technologies) of thin films for low to medium level rf shielding requirements.

A90-327 TITLE: Dual Polarization Ultra-Wideband Antenna

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop a small, non-dispersive, wide bandwidth antenna. The frequency range of interest is 20 MHz to 2 GHz. A critical parameter is the ring time of the antenna; ideally, it is desired that the antenna to propagate an EMP with only one zero crossing when excited by a step input. It is desired that the front-to-back ratio be 10 dB over a ±40 degree back-lobe. The front lobe can cover ±40 degrees or more. Proposals that identify structures that minimize the ring-time, maximize the efficiency with respect to size, and maximize the front-to-back ratio are solicited. Also, proposals that identify structures that can be mounted to the side of an aircraft or perhaps underneath in a raydome are solicited.

DESCRIPTION: Current wideband antenna technology is dispersive and large. There exists within the Department of Defense a need for a compact, dispersionless, dual-polarization antenna for broadcasting and receiving short, high peak-power pulses that cover a bandwidth of 20 MHz to 2 GHz.

Phase I: Analysis. Phase I can focus on computer modeling of promising structures. Time domain or frequency domain Electro Magnetic (EM) codes such as Thin Wire Time Domain (TWTD) or Numerical Electromagnetic Code (NEC-2) might be modified to support analysis of promising structures.

Phase II: Development and testing. Phase II will focus on experimentally verifying the performance of a structure whose modeled performance looks good.

A90-328   TITLE: Digital Waveform Generation for Very Wideband Army Radars

CATEGORY: Exploratory development

OBJECTIVE: New development or bandwidth extension of available integrated Direct Digital Synthesis (DDS) chips which support high clock sampling speeds and allows implementation of simple or complex modulation waveforms. Phase III applications would involve Unmanned Aerial Vehicle (UAV) MTI and Synthetic Aperture Radar (SAR) technology, including Multistatic radar and communication link modes of operation. Power
efficiency, low cost, lightweight and reliable multimode operational capabilities are UAV critical requirements.

DESCRIPTION: Present DDS and Numerically Controlled Modulated Oscillators (NCMO) chips can generate fast, accurate, regular and modulated sinewave outputs but are constrained by clock sampling rates for very wideband applications and power efficiency operation. What is needed are VLSI chips using Gallium Arsenide (GaAs) technology to generate wideband (>200 MHz), fast-hopping, low harmonic and non-harmonic (-50 dbc) spur outputs with clock frequency stability and phase noise characteristics.

Waveform implementation for radar applications include: Linear Frequency chirp modulation bandwidth of >200 MHz; Time-Stepped Frequency Coding; Poly-Phase coding; Quadrature Synthesis output capability. Digital Communication schemes include: Binary Phase-Shift Keying (BPSK), QPSK and 16PSK.

Phase I: Technology survey, analysis, investigation of waveform software requirements, and measurement of existing devices. The survey should include presently available or experimental IC devices that meet the bandwidth modulation requirements. Cascading or paralleling of IC devices may be warranted. Commercial temperature ranges and laboratory instrumentation environment is predicated for initial prototype demonstration. The analysis should include overall chip(s) electrical performance and recommended chip(s) fabrication processing techniques.

Waveform software requirements will be utilized by an advanced high-speed microprocessor (airborne). Measurements of existing devices will be used to extrapolate performance.

Phase II: Develop, test, characterize and deliver two working units. DDS/Modulation waveform design characteristics will be determined and IC chip functions will be simulated. Layout and fabrication of chip(s). Demonstration and evaluation of the chip(s) electrical performance.

A90-329   TITLE: GPS Frequency Translator Integrated Circuits

CATEGORY: Advanced Development

OBJECTIVE: The objective is to field a frequency translator to re-transmit Global Positioning System (GPS) satellite signals. A remote receiver will be able to determine the location of the translator by processing the translated GPS data in applications such as artillery spotter rounds, weather radiosondes, robotics, etc.

DESCRIPTION: A frequency translator chip set is required for development of locating systems utilizing the GPS. The physical size of the translator must be kept to a minimum so that antenna and power supply systems can also be packaged in a small volume suitable for a variety of applications, including artillery projectiles. Any reductions in translator size would greatly improve the feasibility of the overall system. The translator shall receive GPS signals, shift them to a selected frequency, add a pilot tone, bandpass filter the shifted signals, and transmit the composite signal at approximately 100 MW or more.

Phase I: Design of translator chips. Phase I will include design of the translator chips.

Phase II: Development and Testing. If Phase I indicates that the translator chips can be manufactured, a number of sample units will be built and tested.

A90-330   TITLE: Surface-Mounted Multi-Layer Chip Varistors

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop and test low cost and reliable surface-mounted multi-layer chip varistors for the protection of sensitive electronics.

DESCRIPTION: Recent advances in integrated circuit technology have resulted in low voltage, low power consumption chips which require low voltage surface-mounted protection from electrical transients. The most suitable candidate for this application is the Metal Oxide Varistor (MOV). An MOV, small in dimensions ($\sim$0.5 mm x 1 mm x 1.5mm), having breakdown voltages in the range of 2.5 to 5V and non-linear coefficients from 25 to 50 is required for this purpose. The cost is also a determining factor; it is estimated that cost per unit of the chips meeting military specification should be less than one dollar.

Phase I: This phase of the proposed SBIR study will consist of fabrication and characterization of these chip varistors. A variety of ceramic materials such as ZnO, SiC, and (Sr,Ca)TiO3 and different processes such as (1) pressing and sintering, and (2) green sheet lamination technique, will be employed in the fabrication of these varistors.

Phase II: This phase of the proposed SBIR study will involve the selection of a few types of the chip varistors developed in Phase I and their characterization and testing in the protection of the advanced, state-of-the-art integrated circuits including VHSICS and MIMICS. The results of this testing will be used to select the most promising design(s) for the chip varistor.

A90-331 TITLE: Over-the-Ground Distance Measurement Device

CATEGORY: Exploratory Development

OBJECTIVE: To develop a device that will enable the measurement of the distance traveled over the ground by a vehicle or a man without the required attachment to a wheel. This will enable installation flexibility due to the development of a navigator which is not vehicle specific as well as one that is a man portable.

DESCRIPTION: Movement of individuals (soldiers and vehicles) on the battlefield is an exceptionally important piece of information. The ability of a vehicle to know its' position at all times greatly enhances effectiveness. In order to measure over the ground movement of a vehicle the odometer is attached to an encoder and the distance traveled by the vehicle becomes a function of the pulse train generated. This is sufficient for applications where the vehicle is known and the hardware can be obtained to attach the encoder to the odometer. In cases where this is not possible, an expensive accelerometer is required and as such the system will not be fielded. If a device could be developed that would measure the linear distance of travel from the motion of the ground under the vehicle, then such a system would be usable in any vehicle available to the soldier. In addition, the device might be adaptable to a man portable navigator so that the distance of a man's travel could be accurately reported without requiring the calibration of the individuals stride length, a process which is very inaccurate.

Phase I: There are numerous devices which can measure motion, however, not all of them are suitable to the navigation application. The first phase of this effort will be focused on the search for a suitable technology to perform this task. This effort will include evaluations of radar based devices, acoustic/ultrasonic devices and concepts based on IR technology. Results of this phase will determine a sensor which would be the best candidate to replace the odometer driven encoder.

Phase II: The selected distance measurement device will be included in the navigation aid system replacing the odometer connection. Performance of the navigator will be monitored over a variety of terrain conditions while monitoring the accuracy of the distance measurements.

A90-332 TITLE: Pulse Power Technology for High Power Microwave Drivers

CATEGORY: Basic Research

OBJECTIVE: Develop innovative system concepts and principal components or subsystems for driving high power microwave (HPM) sources for the Army's simulation program.

DESCRIPTION: Pulse power drivers for HPM generators are needed that can produce flat-topped voltage pulses (1-2 MV) in loads with ≤ 30 impedance and with pulse duration up to 1us at high repetition rates (≥ 10 Hz). These drivers should be semi-transportable, efficient, and have high reliability. New approaches are sought in the pulse power technology of these systems and critical components such as high voltage generators, pulse forming sections, switches, and loads (exclusive of the issues concerning microwave generation and transmission).

Phase I: The results of this effort should prove the feasibility of the concept through calculations, simulations, designs, and preliminary experiments.

Phase II: The Phase II effort will include additional theoretical or computational evaluation, as well as the detailed design, fabrication, and testing of a working model. The results should provide a demonstration of the principal features of the system or device that are to be optimized in Phase III.

Phase III: The hardware should be optimized and developed to the stage where it can be routinely used for HPM generation for both the government and industry.

A90-333 TITLE: High Sensitivity Wideband Miniature Optical Links

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop and test a miniaturized analog optical data link capable of transmitting the RF output of a miniature sensor to remotely placed recording instrumentation. The size of the transmitter must be smaller than 7.5 cm3, with a sensitivity of at least 20u volts (measured from signal peak to tangential noise), and an operational bandwidth from 10K to at least 2GHz.

DESCRIPTION: With the fabrication of the Army's new criteria HEMP simulators nearing completion and fielding due within the next two years, a miniature wideband optical link has yet to be developed that can be used to isolate the output of electric and magnetic field sensors used to characterize the electromagnetic environment produced over the large test volumes of these facilities. Because of the small wavelengths anticipated, existing wideband optical links cannot be used for this application since the size of these devices will perturb the fields being measured. Areas to be investigated should include efficient laser/photodiode optical links (capable of being remotely operated for a minimum of 3 hours from miniature replaceable battery packs), passive optical bulk crystals, or electro-optic devices.

Phase I: Identify candidate optical transmitting device. Tested theoretical models or bench testing will be necessary to demonstrate feasibility.

Phase II: Development and testing. Additional development and testing to improve reliability and practicality of use. Field testing of prototype link will be necessary.

A90-334   TITLE: Apex Sensor for Mortar Fuzes

CATEGORY: Exploratory Development

OBJECTIVE: To explore the possibilities of achieving an apex sensor for motor fuse safety.

DESCRIPTION: In multi-function fuzing for mortar projectiles, one fuze function involves sensing an area target by use of a proximity sensor employing radio transmission and subsequent ground reflection from the target. It is desirable to delay the turn-on of the proximity sensor until after the apex of the trajectory in order to reduce the possibility of early functions due to electronic faults and to reduce the possibility of detection and neutralization of the fuze by jammers. However, the turn-on must be accomplished without inputs from the soldier. Thus an approach such as the setting of a turn-on time for the proximity sensor after reference to firing table data would be inappropriate. What is needed is a simple sensor and electronic processing circuit which would use information from the flight environment to determine and indicate when the projectile has achieved the apex of the trajectory. It should be borne in mind that the projectile is in free fall and thus its internal components will not inertially recognize an up-leg versus down-leg orientation along the trajectory. However, environmental signatures such as ram air pressure and drag do vary along the trajectory as the velocity changes, with minima occurring at the apex. Of these two environments, pressure seems the more useful because the drag is very small, only a fraction of a "g", under all flight conditions. However, even pressure may be difficult to sense because the range of flight conditions causes pressure changes to range from a few psi out of ten, down to a tenth of a psi out of a few tenths. A sensor with dynamic range and signal processing that can distinguish the transition from pre-apex decreasing pressure to post-apex increasing pressure may be needed. Other approaches may be possible. Target size for the apex sensor is less than 0.01 cubic inch exclusive of the electronic circuit. The electronic circuit should be capable of being integrated with the rest of the fuze electronics. The target cost for the sensor exclusive of the circuitry is less than $1 each in quantities of 100,000 units. Detail designs, functional prototypes (packaged sensors and breadboard circuits), and a formal descriptive report are the desired output from Phase I. Proposals will be evaluated on various factors to include: potential to meet performance requirements, potential to meet size and cost targets, and potential reliability.

A90-335   TITLE: Frequency Translator GPS Signal Receiver

CATEGORY: Advanced Development

OBJECTIVE: The objective is to field a frequency translator to re-transmit Global Positioning System (GPS) satellite signals. A remote receiver will be needed to determine the location of the translator by processing the translated GPS data. Applications might include artillery spotter rounds, weather radiosondes, robotics, etc.

DESCRIPTION: A translated GPS frequency signal receiver is required for development of locating systems utilizing the GPS. The receiver should be a military GPS receiver capable of being modified to utilize aiding to locate the translator. The GPS translator may be a frequency shifter or a transdigitizer. Receiver hardware and software would be modified as needed to retrieve the GPS signal.

Phase I: Study of feasibility of modifying military receivers to operate with translators.

Phase II: Development and Testing. If Phase I indicates standard receivers can be used, one or more will be modified and tested with actual translator hardware.

A90-336   TITLE: Improved Transient Suppressor

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop and fabricate mass producible coaxial surge suppressors with subnanosecond clamping speed and stable operating characteristics.

DESCRIPTION: There is a need for an ultra fast transient protection device to protect HF, VHF, and UHF Communications equipment against EMP as defined in MIL-STD-2169. For the systems requiring protection, the antenna is the coupler of EMP into the system. Excitation of these antennas by an EMP event will induce a high voltage fast risetime transient at the input to the equipment which may cause damage. Existing protective devices with sufficient switching speed tend to behave erratically when subjected to repeated fast risetime voltage transients. Thus, there is a need for high speed transient suppressors with stable response characteristics. (The devices desired should be configured in a coaxial package with type N connectors.) The desired electrical characteristics are listed below.

Clamping voltage:	300 to 600 v
Response time:	$t < 1$ nS
Surge withstand capability:	$ip > 100$ A
Off state resistance:	> 1 megaohm
Repeatability:	device must withstand 100 pulses at rated clamp voltage and surge current
Insertion loss vs. frequency for coaxial package:	± 1 dB from DC to 1 GHz

Phase I: Phase I would include the survey and identification of candidate varistor materials with the requisite activation speed and energy absorbing capacity. Bench testing would be required to determine device characteristics over long time intervals under heavy usage.

Phase II: Further development and testing of prototype varistor arrestors. Optimal mechanical designs will also be pursued under this phase.

A90-337   TITLE: Fluoboric Acid Electrolyte Analysis by Ion Chromatography

CATEGORY: Exploratory Development

OBJECTIVE: To develop a method for the rapid analysis of fluoboric acid by ion chromatography.

DESCRIPTION: Liquid reserve batteries are used to supply electric power to many spin stabilized artillery delivered proximity fuzes. Fluoboric acid solution is used as the electrolyte in most of these liquid reserve batteries. HDL drawing 10974339 requires chemical analyses be done on the electrolyte to determine fluoboric acid (as tetrafluoborate), boric acid, and sulfate contents. The prescribed analytical procedures involve long and tedious wet chemical methods, some of which must be done at 0 degrees F to minimize side reactions that will introduce errors. Since they are manual operations and involve visual observation of titrametric end points, these procedures are prone to human error. For each shipping container of electrolyte, up to three days of laboratory work are needed in order to quantify the three components. Further, the present wet chemical analyses identify only specific components of the acid. Therefore, the acid may pass all the wet chemical method tests but still have undesirable contaminations. For example, one common way that the power supply producer may lower an excessive sulfate content is to add lead fluoborate. This has the effect of reducing available active electrolyte, since it puts a preliminary bias in the cell reaction equilibrium. The current tests do not show excessive lead ion content, and hence cannot be used to monitor this undesirable action of the contractor.

Phase I: The problems associated with the wet chemical method may be overcome by using Ion Chromatography (IC). Previous studies in our laboratory have shown that fluoboric acid may be analyzed in about 30 minutes using a potassium hydrogen phthalate solution as eluant, a Wescan Anion/R column, and a Wescan 213 conductivity detector. It has also been shown that IC can be used to find contaminants in the acid that the wet methods do not detect, such as bromide, sulfate, or lead. We anticipate that other equipment, columns, techniques, etc. would also be effective. We expect that total labor time for the analysis of a single shipping container of electrolyte involving testing of replicates will be reduced from approximately 24 man hours to about 2 man hours. Approximately three to five shipping containers would be analyzed per week on a specific production program. Use of an autosampler will lead to additional labor savings, reducing the average analysis time to about 1 man hour. This phase includes the development of the process and the delivery of all hardware (including analytical instruments) and software.

A90-338   TITLE: Weather Sealed, RF Shielded External Entry Vault

CATEGORY: Engineering Development

OBJECTIVE: To reach Phase III, the objective is to construct and test a weather sealed, RF shielded entry vault (EV) unit capable of being mounted on the exterior of a van or shelter. The completed EV shall be weather proof (in accordance with NEMA 4R requirements) and provide an RF shielding performance goal of 80 dB (radiated), as tested by a MIL-STD-285 type test.

DESCRIPTION: A modular EV unit constructed mainly of commercially available components which provides both weather protection and RF shielding to electrical components is desirable for protection of tactical/strategic mobile/transportable DoD systems. Currently, weather proof externally mounted EVs are unavailable commercially. Electrical boxes which provide weather protection (IAWNEMA 4R) are commercially available. It is believed to be feasible to have an EV developed which meets the DoD requirements. The EV shall be designed to hold a complement of filters and ESAs normally found inside of an EMP protective EV for single/multiphase power filtering/entry.
    Phase I: Design and Fabrication. Phase I will include design and fabrication of the EV unit. An initial investigation of current NEMA 4R designs will be conducted. Since ruggedness and fabrication cost will be of importance in an ultimate application, comments on these items also shall be made in the proposal and at the conclusion of the first phase of the investigation.
    Phase II: Test and Demonstration. The second phase shall consist of the field testing of the installed EV units on a preexisting test facility. During this phase, the EV shall demonstrate the ability to meet the stated performance goals.

A90-339   TITLE: Low Cost Angular Rate Sensor

CATEGORY: Advanced Development

OBJECTIVE: The availability of a low cost angular rate sensor with accuracy suitable for use in autonomous navigation applications, would enhance the utility of combat information processing equipment by allowing a much more timely (and accurate) update of information on locations ,and of movement of equipment, units and even individual soldiers on the battlefield. The objective of this SBIR effort would be to develop a low cost sensor capable of operating in the battlefield environment so enough of them can be fielded to provide locations and movement of battlefield operations. Such a device would enhance the effectiveness of each unit because of the certainty of the relative locations of units within the battlefield.

DESCRIPTION: Currently available low cost angular rate sensors do not have suitable accuracy and stability to be applied to the task of a navigation aid for either vehicles or individuals. Currently available autonomous navigation aids are far too expensive to be widely enough applied to make a significant impact on the location of soldiers and units on the battlefield. For units in continual movement, GPS is not suitable because of uncertainties of satellite acquisition from behind foliage and terrain. GPS would be useful in obtaining starting locations and updates, but for realtime movement on the battlefield, giving consideration to the mobility required, it would be unsuitable.
    Phase I: The most critical component of the Navigation Aid is the angular rate sensor in that it must measure turning rate and will govern the accuracy of the heading obtained by the navigation computer. Current experience involves a fluidic angular rate sensor but candidate sensors could be based on a vibrating quartz device, the fiber optic gyro or possibly a microscale gyro. The results of Phase I will be to select a sensor from a list of candidates. The selection process will not only consider performance characteristics but maintain as low a cost as possible. Typical sensing range of this device must be $\pm$ 100 deg/sec with a resolution of 0.002 deg/sec. Bandwidth of the sensor need be no higher than 10 Hz and it must have a scale factor calibration of at least 0.5% of value. An operating temperature range of -55 degrees C to +100 degrees C is also required.
    Phase II: Once a sensor has been selected from Phase I, a representative sample will be procured for testing and evaluation. Testing of the device, particularly with respect to the effects of temperature, will be of the utmost importance since some form of temperature compensation or thermal heating may be required. Evaluations will be made with respect to stability of performance characteristics, expected useful life and performance when integrated with the navigation CPU.

A90-340   TITLE: Application of New Generation Computer Technologies to Coupling/Scattering

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is the development of new hardware and software approaches to the numerical solution of Maxwell equations in the presence of dielectric and conductive objects. The approach will take advantage of new computer hardware development (e.g. parallel processing) and mathematical and software development (e.g. AI, fractals, numeric algorithms).

DESCRIPTION: Existing numerical approaches to the solution of the Maxwell equations take a brute force approach to obtain results. A need exists for the development or refinement of Maxwell solvers which take advantage of recent advances in computer hardware, software and applied mathematics. Time domain approaches, which can accommodate non-linearities, are of greatest interest. Frequency domain approaches are also sought.

Phase I: Recent advances in computer hardware and software and in applied mathematics will be surveyed to determine their relevance to the formulation of new Maxwell equation solvers. At least three combinations of approaches will be evaluated. The evaluation will be done through analysis, emulation, and/or direct application. Phase I will end with at least one specific approach.

Phase II: The approach or approaches identified from Phase I will be implemented in software and hardware. Canonical problems will be solved and the results compared to theory and brute force methods. The advantages and disadvantages of the approaches will be delineated. Phase II will end with the full documentation of the approach or approaches selected. Phase III is anticipated to be the development of a commercially available hardware/software Maxwell solver.

A90-341   TITLE: Microwave Absorptive Materials

CATEGORY: Exploratory Development

OBJECTIVE: Low cost microwave absorptive materials are required to protect components/devices and equipment from high-power microwaves (HPM). The objectives are to identify, characterize and evaluate sample absorptive materials under Phase I. These materials should be applicable for printed circuit board coatings, coaxial/waveguide low-pass/high-pass and pass-band filters, radomes and antennas coatings/covers. The materials should have greater than 20 dB out-of-band absorption, less than 0.5 dB in-band insertion loss, an absorption versus frequency profile which increases rapidly with frequency, and low cost design. Composite materials of ferromagnetic and polymers should be investigated to achieve the degree of absorption and frequency selectivity.

DESCRIPTION: Significant progress has been made over the past decade in developing radar absorbing materials (RAM). This project is aimed at improving RAM by providing both a transmission window with low-insertion loss and high out-of-band absorption. The techniques and materials developed should be capable of being tailored for various frequencies and bandwidths throughout the microwave spectrum (300 MHz - 300 GHz). The DOD has a critical need for these new, low cost absorptive materials to negate the HPM hostile environments both existing and projected.

Phase I: Identification and characterization of candidate materials. Phase I will include a survey and establishment of a database of microwave absorptive materials. Sample materials will be tested and evaluated to determine absorption effectiveness and figure-of-merit.

Phase II: Develop engineering prototype microwave absorptive materials. If suitable candidate materials are identified under Phase I, tests and evaluations will be performed on selected materials, and lowcost techniques and designs developed for specific applications. Phase II will include a hardware demonstration package.

A90-342   TITLE: Electro Magnetic Pulse (EMP) Coupling to Cables

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop a complete solution to the problem of a right cylindrical conductor (cable) over a conductive dielectric half space (ground). The solution must accommodate all ranges of 2/a and 2/h where 2 is the wavelength of the incident radiation (plane wave), (a) is the diameter of the conductor and (h) is the height of the cable (conductor) over the "ground" plane. All polarizations and angles of incidence must be included. All practical conductivities and dielectric constants are to be addressed. The logical Phase III goal would be the integration of the results into a generalized coupling/scattering code or methodology.

DESCRIPTION: Current electromagnetic coupling-to-cable codes and prediction methodologies are limited in their capabilities. Transmission line approaches generally ignore the multiple ground scatter and suffer inaccuracies when 2/h and/or 2/a are close to or less than 1. Finite difference approaches are limited by computer memory and computer cost. Greater accuracy and more efficient methods are required for the calculation of coupling to long cables over the real earth.

Phase I: The numerical and/or analytic model(s) will be formulated. The model(s) will be applied to simple problems (e.g., perfect conductor over a perfect ground plane) to establish initial validity.

Phase II: The model(s) will be verified by comparison to specific solutions in the technical literature and by test. (HDL facilities and equipment will be made available for such experiments.) The model(s) will then be formatted into a user friendly code or methodology.

A90-343   TITLE: Non-Linear Effects Produced by Electro Magnetic Environments

CATEGORY: Basic Research

OBJECTIVE: To reach Phase III, the objective is to develop a self consistent theory of air breakdown in apertures illuminated by an Electromagnetic Pulse. The theory is to be subjected to an experimental verification, and used to predict the amount and character of the energy that leaks past the aperture.

DESCRIPTION: Develop a theory of air breakdown (arcing) in apertures illuminated by Electromagnetic Radiation with characteristics similar to that found in the Electromagnetic Pulse. The calculation of the electric field in the aperture may be decoupled from the plasma dynamics, however the solution of the diffusion equation should be self consistent. The quantity of interest is the amount of energy tnat leaks through the aperture after the breakdown is initiated. The theory should identify all of the assumptions/approximations employed and the regions of applicability should be addressed. The effect of the aperture geometry, the parameters of the incident radiation, and any air/gas environment parameters that can affect the initiation of arcing should be identified. Comparisons with experimental data should be made and experiments should be performed to verify that air breakdown occurs as predicted.
    Phase I: Addresses the theoretical analysis of the topic. It is expected that numerical/computational models will be required for the investigation. Emphasis should be placed on providing an understanding of the physics of arc breakdown. The results of the latest studies involving leader formation in lightning and new information on air chemistry must be taken into account.
    Phase II: The basic theory developed in Phase I will be applied to a simple canonical model. It is expected that an experiment will be designed to verify the basic theory and provide feedback to refine and modify the initial theory to obtain more accurate results. The results of this investigation should lead to identification of configurations for which arcing is likely to occur, and recommendations for design practices to protect against unwanted arcing.

A90-344   TITLE: Fast-Risetime, Direct Connect and Magnetically Coupled Cable Driver System

CATEGORY: Exploratory Develop . .

OBJECTIVE: A cable driver system delivering a fast-risetime current pulse into an arbitrary impedance multi-conductor cable is required to supplement free-field HEMP illumination of Army tactical systems.

DESCRIPTION: A cable driver system delivering a fast-risetime current pulse into an arbitrary impedance multi-conductor cable is required to supplement free-field HEMP illumination of Army tactical systems. Required current injector specifications are as follows:

Peak Amplitude:	200 A. - 10 kA.
Risetime (10-90%):	$\leq$ 10 ns. (goal $\leq$ 1 ns.)
Pulse Shape:	Double Exponential
First Zero Crossing:	100 ns.
Undershoot:	< 10%
Output Impedance:	50 ohms

The cable driver system should have the capability to supply a load pulse as described in the above technical specifications through either direct connection or via magnetic coupling to the cable in question. Response characteristics of ferro-magnetic materials at high-frequencies (>1 GHz) may impose severe limitations on the design and fabrication of the magnetically coupled injector. Present technologies for supplying a fast-risetime pulse to a load (cable) rely upon "direct-connect" techniques due to the frequency limited materials response of the ferro-magnetic couplers. Proposals which identify methods for overcoming the known deficiencies of these types of materials are solicited.
    Phase I: Develops candidate conceptual designs for a magnetically coupled current injector which meets the aforementioned technical specifications. This injector design shall also possess the capability to quickly and easily be converted into a direct-connect geometry exhibiting identical performance characteristics to thuse discussed above. Analytical analyses and scale model testing of prototype materials/designs will be included in the Phase I design effort.

Phase II: Consists of the fabrication, checkout and acceptance testing of a complete current injection system (direct-connect and magnetically coupled) which demonstrates the ability to meet the above performance goals.

A90-345   TITLE: Wideband Electric Magnetic Field Sensors

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop, test and fabricate miniature wideband passive groundplane electric and magnetic field sensors that operate with a flat frequency response from 10k to 1.5G Hz. Each sensor will output a voltage directly proportional to the measured field and will work into 50 ohms.

DESCRIPTION: Because of the small wavelengths associated with measuring fields in the GHz regime, it is imperative to minimize sensor size. This limitation prohibits the use of present sensor designs which incorporate active impedance matching networks and an accompanying battery pack. It is advantageous for each sensor to have a flat response over the entire frequency range although two sensors may be used as long as each sensor covers at least four frequency decades. The target sensitivity of the electric field sensor should be 500 volt/meter/volt (ratio of applied field to sensor output voltage). Target sensitivity for the magnetic field sensor should be 50 Amps/meter/volt. Each sensor would be mounted to a metallic ground plane with a thickness of no more than 0.5 inches.
    Phase I: Identify optimum sensor and passive loading circuitry design. Demonstrate recommended sensor design either through tested theoretical modeling or bench testing.
    Phase II: Fabrication and testing of prototype sensors along with calibration data.

A90-346   TITLE: Dyadic Green's Function for Anisotropic Substrates

CATEGORY: Basic Research

OBJECTIVE: To reach Phase III, the objective is to develop an analytically efficient asymptotic closed form Dyadic Green's function for anisotropic layered substrates. The analytical form will be implemented numerically in standard FORTRAN coding for application to electromagnetic problems.

DESCRIPTION: The formal representation of the Dyadic Green's functions for anisotropic, and isotropic substrates, contain infinite double spectrum (or Sommerfeld type) integrals that must be calculated numerically. Recently, a closed form asymptotic representation for single and double layered Green's functions have been presented in the literature, which remain accurate for lateral separations of the source and observation points as small as a few tenths of a free space wavelength. These asymptotic representations have been proven to be an essential tool for development of highly efficient computer codes for analysis of various integrated circuit structures, as well as microstrip finite phased arrays, involved in single and double layered isotropic media. It is of interest to pursue the same route of function-theoretic and asymptotic analysis used for the isotropic case, to develop an efficient asymptotic closed form version of the Dyadic Green's function for anisotropic substrates. The closed asymptotic form of such a Dyadic Green's will be valuable in the numerical analysis involving anisotropic and composite materials, as well as understanding the physics of such structures.
    Phase I: Proof of principal study to determine if the isotropic formulation can be extended to the anisotropic substrate case without losing the desirable analytic properties. Comparison with canonical special solutions to establish accuracy and reliability as a function of the dominant parameters such as frequency spectrum, source substrate separation, and media parameters.
    Phase II: Develop the numerical models and algorithms and implement the FORTRAN coding. Test the computer code on a simplified integrated circuit configuration such as a microstrip phased array. Document the codes and all results. Investigate community interest in marketing the algorithms as a set of design tools to complement existing high frequency (millimeter to optical) integrated circuit design tools on platforms such as the microcomputer and the minicomputer.

A90-347   TITLE: Composite Materials for Communication Shelters

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop and test composite materials to absorb electromagnetic radiation and yet, are structurally strong to withstand battlefield stress.

DESCRIPTION: Current communication shelters are made of sheet metals. Therefore they have very distinctive laser and radar signatures and become easy targets for present and future smart weapons. Existing technology for the stealth bomber can be researched for applicability to communication shelter construction with the purpose of minimizing the shelter signatures, shielding against nuclear electromagnetic pulse and withstanding battlefield stress.

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Phase I: Investigation of candidate materials. Phase I will include the survey, identification and collection of samples of candidate materials. Where possible engineering and spectral properties will be determined from existing literature.

Phase II: Development and Testing. If suitable candidate materials were identified during Phase I, additional testing and development of techniques for improving their mechanical and multispectral properties will be conducted if considered essential for battlefield application. Phase II will include prototype shelter construction and testing and analytical analysis with respect to shielding, signature and stress.

A90-348   TITLE: Reforming Radio Frequency Interference Door Gaskets

CATEGORY: Exploratory Development

OBJECTIVE: To reach phase III, the objective is to develop, test, and fabricate a practical low cost reforming RF door gasket and pressurizing mechanism. The gasket must easily accommodate existing door designs while providing a minimum of 60dB shielding (at 150 kHz) to magnetic fields for a period of 2 years.

DESCRIPTION: Presently a wire mesh gasket with a solid silicon core is used to minimize the electrical discontinuities present between an entry door and enclosure body. A major disadvantage to this gasket design is its ease of use and low cost. A major drawback through, is the gasket's inability to maintain a reasonable RF shielding value for more than several months. A major cause for this shielding degradation can be linked to the inability of the silicon core to expand to its original shape after extended use (referred to as "gasket set"). A possible solution to this problem would be to replace the solid gasket core with a hollow core and then add pressure to the gasket each time the door is opened to expand the gasket to its original shape. By assisting the gasket in expanding to its original shape, shielding degradation could be minimized. Pressurizing mechanism should not require power.

Phase I: Phase I would include the survey and identification of candidate gasket and pressurizing mechanisms in relation to the Army's more commonly used gasket mating surfaces. Prototype tests will be necessary to demonstrate feasibility.

Phase II: Additional testing and development to improve reliability and practicality. Working prototypes will be used to monitor shielding degradation as a function of time.

A90-349   TITLE: Low Cost Liquid Crystal with Touch Pads

CATEGORY: Advanced Development

OBJECTIVE: Most military systems today contain computers and require user input while providing some output which the soldier must visually see to utilize the system in his mission. The objective of this effort would be to provide a low cost military Liquid Crystal Display (LCD) with graphic/alphanumeric capability, a size of about 64 x 240 pixels and would include touch areas to allow for software programmable computer input.

DESCRIPTION: Any system which has a computer has a power budget and costs can usually be reduced by keeping component count down. The LCD has been a widely used device commercially since it has low power requirement and is relatively inexpensive. However, the device has not been widely used in the military because its viewability has not always been acceptable both from viewing angle as well as over temperature range. The capability of including software programmable touch areas to the LCD adds to its utility since the user then has just one component, a low power display and an exceptionally versatile keyboard. The cost of such a device when military specifications are a requirement can become prohibitive. Viewability over the mil spec temperature range would allow the inclusion of such an input device in a wide range of system applications where low power low component count would have advantages. A particular application would be the Navigation Aid (NAVAID) developed at HDL. For an application like the NAVAID the LCD/touch device should cost no more than $500 in quantities of about 5000.

Phase I: This phase would survey existing LCD technology with particular emphasis on cost reduction techniques and performance over mil spec temperature range. A design will be produced which would be suitable for application to the NAVAID including programmable touch areas.

Phase II: Fabrication of prototype mil spec LCD/touch displays for use with NAVAID. These devices will be suitable for fielding with prototype NAVAID units which are currently in use in fielded applications.

A90-350   TITLE: Low Maintenance Door Closure

CATEGORY: Exploratory Development

OBJECTIVE: To reach phase III, the objective is to demonstrate a method of providing an RF seal for screen room type doors using electromagnetic methods. The completed prototype will have a performance goal of 60 dB shielding effectiveness to magnetic fields (at 150kHz), as tested by a MIL-STD-285 type test.

DESCRIPTION: A method of providing an RF seal for screen room type doors using electromagnetic methods is sought. Current door designs rely upon fingerstock and wire mesh gasketing to provide an RF seal. As these seals age, they become degraded due to oxidation, pressure setting, physical damage and general wear. It is desirable to find and demonstrate methods which will reduce the DoD's reliance on such mechanical methods for obtaining RF seals. The use of an electromagnetic seal is expected to greatly enhance the longevity of RF seals, while reducing the maintenance burdens.

Phase I: Preliminary Design. The first phase will consist of an investigation of a specific type of an electromagnetic door seal. The investigation will include analysis and/or experiments that result in a preliminary design, an estimate of how well the design will achieve the performance goals of 80 dB shielding effectiveness, and the fabrication and testing of a small prototype (as measured using modified MIL-STD-285 techniques). Since ruggedness and fabrication cost will be of importance in an ultimate application, comments on these items also shall be made in the proposal and at the conclusion of the first phase of the investigation.

Phase II: Fabrication and Test. The second phase shall consist of the fabrication and test of a full size door that demonstrates the ability to meet the above performance goals. This door will be installed and field tested in a preexisting test bed.

A90-351   TITLE: Electron Collision Cross Sections in Air

CATEGORY: Basic Research

OBJECTIVE: To reach phase III, the objective is to obtain electron collision cross sections in air, where the electron energy is thermal to 1 keV. The cross sections need to be obtained in such a manner that electron mobility and avalanche rate can be extracted for ionized air even when the electric field is changing rapidly (over tens of kV/m) compared to the electron thermalization time.

DESCRIPTION: Current cross sections for electrons with N2 and O2 (and H2O) in the low energy range are quite inadequate for determining the electron thermalization rate. Electronic conduction parameters of ionized air in which the electrons are not in equilibrium, such as electron mobility and avalanche rate, therefore, cannot be adequately determined currently.

Phase I: Conception and design of experiments from which the needed cross sections can be obtained. Construction and set up of the experimental apparatus.

Phase II: Execution of the experiments, including resolution problems that arise during their execution. Data analysis of the results.

A90-352   TITLE: Pulse Sharpening for the AURORA Flash Gamma Ray Simulator

CATEGORY: Basic Research

OBJECTIVE: Apply advanced pulse power techniques to dramatically reduce the risetime of the radiation pulse produced by the AURORA Simulator.

DESCRIPTION: An order of magnitude reduction of the radiation pulse risetime is of interest for gamma-ray simulation. This pulse sharpening would provide higher performance than is presently available by complementing existing electron beam/gas transport systems or by replacing the need for them. Novel approaches to pulse power systems that would modify or be added to the AURORA machine are desired. This simulator presently produces pulses of up to 1^ MV on each of 4 output transmission lines. The pulse power risetime of the present system can be ~ 50 ns. Techniques that might provide the sharper rising pulse should make effective use of existing hardware. Such techniques must be compatible with existing space constraints and the operational requirements imposed by simulation methodology.

Phase I: The results of this effort should prove the feasibility of the concept through calculations, modelling, designs, and preliminary experiments. The basic scaling laws for the hardware should be compiled, and a plan to test the scaling in Phase II should be formulated.

Phase II: A scaled prototype should be designed, fabricated, tested, and evaluated. The basic scaling laws should be validated. The results should be extrapolated to a preliminary design of hardware that could be installed and tested on AURORA in Phase III.

Phase III: Further development and a final design should be performed. Hardware should be fabricated, installed, and tested on the AURORA machine.

A90-353   TITLE: Vortex Shedding Mitigation Methods

CATEGORY: Engineering Development

OBJECTIVE: To reach Phase III, the objective is to characterize and mitigate the mechanical stress effects on fiberglass reinforced plastic structure tubing due to vortex shedding.

DESCRIPTION: In areas such as high frequency antenna test sites and support structures, it is imperative to minimize the perturbation the structural building members have on the electromagnetic field being generated. Because of its electromagnetic characteristics, these sites commonly use fiber reinforced plastic (FRP) structural tubing as supports. The use of structural tubing, though, has resulted in an inherently flexible structure. The long unsupported length, moment of inertia of the sections and Young's modulus of the FRP columns result in a relatively low natural frequency in lateral vibration in flexure of the uniform columns. If the frequency of an exciting force coincides with one of the natural frequencies of the structure or isolated member(s) in the structure, the structure could be set into vibration. A steady state wind passing around a structural member such as a cylindrical support column, could create a system of Karman vortices in the wake of the member and produce this exciting force.
    Phase I: Consists of an assessment of vibration severity for both short and long term intervals and an investigation of typical methods used to mitigate this effect in the design of large flexible structures.
    Phase II: Consists of further development and scale model testing of the approved design.

A90-354   TITLE: Alternate Electromagnetic Pulse (EMP) Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III, the objective is to develop, evaluate the fidelity of and establish use methodology for EMP simulators which will have minimum environmental impact. Environmental concerns surrounding the use of "free-field" EMP simulators have resulted in a shut down of Army EMP simulator operations; new high fidelity low-environmental-impact simulation methods and hardware are solicited.

DESCRIPTION: Current free-field simulation methods and some direct drive approaches to EMP simulation are of a concern from personnel and environmental impact issues. New methods are sought. These new methods must be high fidelity simulations and must be practical to implement from hardware, software, personnel and organizational standpoints.
    Phase I: Candidate approaches will be identified. The features of each approach will be detailed. In particular the fidelity and practicality of use will be estimated. Analytic and numeric evaluations will be used to support candidate approaches. Environmental Impact will be estimated.
    Phase II: Candidate approaches will be implemented and the fidelity of each will be evaluated by test and analysis. Parameters of the methods which may affect personnel or the environment will be monitored. Phase II will conclude with a recommended alternate EMP simulation approach (or approaches) for the Army.

A90-355   TITLE: AURORA High Power Microwave Testing

CATEGORY: Basic Research

OBJECTIVE: Develop innovative devices for microwave transmission elements, or major components to enhance the capability for high power microwave (HPM) testing performed at the AURORA Facility.

DESCRIPTION: HPM research, development, and simulation testing is performed on the AURORA machine at frequencies $\leq$ 3 GHz. AURORA is a pulse power generator that can deliver 12 MV pulses at a power level approximating 3.6 TW on each of 4 output lines. Advances are sought in the generation of microwave pulses, the transmission of these pulses to a test area, and key subsystems and components.
    Phase I: The results of this effort should prove the feasibility through calculations, simulations, designs, and preliminary experiments.
    Phase II: The Phase II effort will include additional theoretical or computational evaluation, as well as the detailed design, fabrication, and testing of a working prototype device that is powered by or used with the AURORA machine. The results should provide a demonstration of the principal features of the device or subsystem that are to be optimized in Phase III.
    Phase III: The hardware should be optimized and developed to the stage where it can be routinely used for HPM generation at AURORA/government and industry facilities.

A90-356   TITLE: Photonics Packaging

CATEGORY: Exploratory Development

OBJECTIVE: Design and development of novel packaging approaches and techniques (manual and automated) for use in design and manufacture of systems consisting almost entirely or completely of photonic/optical components and parts. These

packaging techniques will provide reduced cost and size as well as higher reliability and quality, make these kinds of systems practical to build and manufacture easily, and apply to military and commercial needs.

DESCRIPTION: The scope of this project is to attack the problem of cost-effective, reliable manufacture and assembly of photonic systems for optical computing, signal processing, etc. using bulk optics, integrated optics, fiber optics or electro-optic components and devices. The advent of light for signals instead of electrical signals in copper, provides unique challenges and opportunities for system packaging design and manufacture. Systems using one technology only as well as hybrids of two or more technologies should be investigated.

Phase I: Development of manufacturing, packaging, and assembly concepts (manual and automated). Complete study short of prototype fabrication.

Phase II: Demonstrate concepts from Phase I by fabrication and test of working prototypes consisting of one photonic technology and one or more hybrid assemblies using two or more technologies.

Human Engineering Laboratory

A90-357   TITLE: Fire Support Applications of Global Positioning System Transponders

CATEGORY: Exploratory Development

OBJECTIVE: To design an expendable GPS transponder system which can be used by the fire support community in applications ranging from registration rounds to radiosondes.

DESCRIPTION: The fire support community needs a small, lightweight GPS transponder which uses very little power that can provide precise positioning information for fuzes, radiosondes, dropsondes and remote target acquisition devices. The cost of these transponders must be low enough ($300 per unit) to allow them to be expendable.

Phase I: Design and fabricate a GPS transponder (including all electronics, antennas and power supply) that will fit into a 10 cubic inch volume. This system must operate for five minutes on its internal power supply and must have sufficient transmitter power to reliably relay (on "S" band) the GPS signals to a ground station 25 kilometers away.

Phase II: Design and fabricate a GPS transponder (including all electronics, antennas and power supply) that will fit into an artillery round fuze. This system must survive the firing shock of 30,000 G's and operate for five minutes on its internal power supply, and must have sufficient transmitter power to reliably relay (on "S" band) the GPS signals to a ground station 25 kilometers away.

A90-358   TITLE: Two Position Combat Vehicle Crewman Seat

CATEGORY: Exploratory Development

OBJECTIVE: Design and demonstrate a two position CVC crew station seat which can be elevated hydraulically or electrical through a vertical range of 24 inches.

DESCRIPTION: Crewmen control combat vehicles from two positions: (1) open hatch (or open protected), and (2) closed hatch. The transition from open to closed may be made when the vehicle is under fire or encounters toxic agents. The transition from the outside "real" world to the internal "virtual" work must be swift and continuous with a minimum of disorientation or readjustment. The optimum system would feature the crewman seated in his station performing his duties with armrest controls and possibly a lap-type console. His open-hatch seat height is adjustable so that he has adequate vision and sufficient clearance from the overhead hatch. When the time comes to "button-up", he activates one switch which (1) returns his station to the longitudinal axis, (2) drops his entire control station to its internal position, (3) closes and seals the hatch, and (4) starts the ventilation/filtration unit. His hands never leave the systems controls, and the major transition is visual from real-world to virtual displays which are right in front of him now at eye level. Transition to open-hatch operation and emergency egress are just the opposite: (1) the hatches open, (2) the seats rise to a pre-set height, and (3) the crewman continues to operate or commences egress.

Phase I: Design and fabricate dynamic mock-ups which demonstrate the required mechanical interlocks, drive mechanisms, and manual back-up features.

Phase II: Incorporate armrest controls and demonstrate continuity of operation over the full range of seat motion. Install system in test-bed vehicle.

A90-359   TITLE: Intelligent Document Retrieval

CATEGORY: Exploratory Development

OBJECTIVE: The goal of this effort is to develop advanced computer system technology that uses new and emerging AI technologies relating to textual retrieval to allow for rapid location, extracting, and assembly of text into meaningful information structures. Information, once stored in the system, must be capable of being assembled in a form which allows for perusal by computer naive nonsubject matter experts using natural language techniques. The system should likewise promote the productivity of the computer proficient subject matter expert (SME) research. Phase III of the system integration of technology prototyped in Phase II would produce a commercially viable product.

DESCRIPTION: The ability to store, retrieve, and manipulate information represented as discrete, numerically based data structures has been the basis of most modern computer technology. Information that is financial, statistical, or hierarchically ordered lends itself well to this technology. Today's Data Base Management System (DBMS) methodologies provide a rather complete suite of tools for the access and query of relatively homogeneous and structured information.

Unfortunately, only a small portion of the information needed by HEL is in this form. Most information generated, utilized, and stored today is in textual format; and very little of that information lends itself to current DBMS technology. That part which is not consistent with DBMS methodologies must be reorganized, distilled, categorized, and reformatted by SMEs before it can be used, stored, and retrieved electronically. This textual information tends to be unstructured -- often intermixed with numeric, graphical, or image data -- and is characterized by heterogeneity in organization, format, and content. Textual databases are usually very large collections of information that frequently exceed the sizes handled by a DBMS.

The recent development of affordable CD-ROM technology, fast computer processors, and reliable optical scanners has highlighted the scarcity of effective automated text retrieval technologies. The hardware side of this problem has been partially solved with off-the-shelf commercially available products. What remains is selection and/or modification of appropriate products and integration of these products into a seamless, integrated system that is compatible with advanced intelligent retrieval software. Software techniques which allow this hardware to perform in a manner which imitates the abilities of an expert human document researcher are being developed in academia and private industry. Both classical statistical and cognitive-based retrieval methodologies which mimic the way the human mind solves the text retrieval problem offer the best promise of effectively employing the power of today's computer hardware in the pursuit of this problem. Examples of areas of high interest to HEL for textual retrieval research include but are not limited to:

- Natural language processing
- Vector and probabilistic modeling
- Linear associative retrieval
- Automatic classification
- Phrase structure grammars
- Automatic thesaurus construction
- Transformational grammars
- Criterion phrases
- Boolean and p-norm models
- Word stemming
- Fuzzy logic

Phase I: Technology Area Review/Analysis. Phase I will include a review/analysis of technology employing AI and/or other classical methods listed above that are being researched as well as those that are being used within academia and industry to address the automatic text retrieval problem. The results/utility of previous and ongoing government programs should also be included. The overall objective of this review/analysis effort is to identify technologies which could be leveraged/adopted to form a potential state-of-the-art prototype system for demonstration in Phase II. In preparation for Phase II, Phase I should develop block and data flow diagrams describing applicable technology algorithms identified and include discussion of the potential algorithm/software technology shortfalls associated with adaptation/integration and potential work-arounds. A requisite for this

Phase I effort would be the adoption of a sound method to evaluate the effectiveness/applicability of each technology reviewed to the overall text retrieval problem.

Phase II: Proof-of-Principle/Demonstration. The Phase II effort will take the technologies identified in Phase I; employ off-the-shelf hardware/software, and, where possible, demonstrate the AI-based technologies'/algorithms' utility in forming a state-of-the-art automated text retrieval system prototype. As a minimum, the leveraged/adapted technology demonstrator must be able to handle free-form, natural language inquiries and automatically search and retrieve relevant text from a database of previously scanned and stored technical documents. Usability by computer-naive users as well aid to computer-proficient users will also be demonstrated.

A90-360   TITLE: Intelligent Interfaces for Artificial Intelligence Planning Applications

CATEGORY: Exploratory/Advanced Development

OBJECTIVE: Exploratory and advanced development efforts in the construction of direct manipulation and graphic interfaces. The objective is to develop a construction kit and interface design environment for knowledge-based planning applications in tactical logistics planning, scheduling, and maintenance.

DESCRIPTION: The Human Engineering Lab is prototyping AI based decision support systems to enhance the prediction of resupply requirements, plan the allocation of transportation assets, rapidly generate and evaluate alternative logistics support plans, and schedule vehicle and equipment maintenance activities. Interfaces for these systems have been developed under UNIX, the X Window System and Motif, to run on a
Sun 4/260 workstation. The objective of this effort is to develop a general purpose, direct manipulation interface "construction kit" and interface design environment based on UNIX, the X Window System and Motif standards. Specific areas of interest are:
      a. INPUT INTERFACES: The interface developer would use this environment to lay out and edit interface objects (windows, scroll bards, buttons, menus, icons, etc.) and give them specific attributes (color, size, position, etc). These objects would have methods to handle display, highlighting, resizing and other appropriate behaviors based on the X library and Motif. The interface design environment would also assist in the linking of functional code to the generated interface code.
      b. OUTPUT INTERFACES: Objects for the display of project planning output are required. Minimum requirements are the standard activity network type technical planning, tracking and monitoring structures, such as CPM, PERT, and WBS, for the display of the knowledge-based planners output. Desired features for the interface design environment include support for the generation of charts, histograms, comparison reports, project calendars and what-if analysis to assist in customizing the planner output interfaces to the logistics domain.
    Phase I: Emphasis should be on application and extension of existing interface building tools which are fully compatible with UNIX, the X Window System and Motif standards. The work should include a serious effort at prototype development (bidders must have their own computing facility).
    Phase II: Emphasis should be on development and field evaluation of fully operational prototype demonstrating the increased effectiveness and added capabilities made possible by the technology.

A90-361   TITLE: Combat Vehicle Automatic Sighting System

CATEGORY: Advanced Development

OBJECTIVE: Design and demonstrate a CRT-based sighting system which will lock-on to a designated target using image contrast, and track the target while both the target and the sighting vehicle are in motion.

DESCRIPTION: Gunners in future Combat Vehicles will be using electro-optic sensors to acquire, track, and engage the opponent. Imagery will be presented to him on high resolution color CRT monitors. Using a hand controller, he should be able to designate a target by centering a sight symbol and pressing a button. Using pixel contrast, the target could be discriminated from the background, and a feedback circuit used to keep the sensor trained and locked-on. The target image would flash when the sensor was locked and tracking. Actuation of a second button would slew the main weapon into alignment with the sensor, and weapon lock-on would be indicated on the sight picture. Another button on the hand controller would actuate the laser range find, and when the range was determined and the weapon elevated and ready, the sight picture would change again to indicate "ready to fire". A trigger switch on the controller would fire the weapon. Another area on the periphery of the sight would show type of round loaded, number of rounds remaining, and other weapon system information.
    Phase I: Design and build a working test-bench system with all of the components, logic, and circuitry. The sensor in this version could be a standard television camera feeding a standard monitor. The hand controller could be either GFE or custom designed.
    Phase II: Install the system on a research vehicle and incorporate into the existing gunner's crewstation. Provide circuitry and logic to align the sensor and main weapon. Demonstrate lock-on and control while both target and sighting vehicle are in motion.

A90-362   TITLE: Development of a Digital Auditory/Speech Processor

CATEGORY: Advanced Development

OBJECTIVE: The need currently exists for an earlevel assistive listening device which digitally processes auditory signals, to include speech.

DESCRIPTION: The device should be able to process signals using in three different listening conditions: moderate to high background noise, impulse noise, and a quiet listening condition. In all cases the desired signal should be enhanced while limiting the overall sound pressure to the ear. The device should be small with output at earlevel. The device must be

programmable with dip switches which will allow variation in: duty cycle, chopping rate, attack time, release time, frequency selectivity, compression, and knee. The unit must also be capable of providing narrow band masking at low levels.

Phase I: The first year should be limited to the assembling of four prototype devices with at least the above capabilities. A pilot study should also be completed which looks at the feasibility of processing a signal imbedded in noise (negative signal to noise ratio) and establishes parameters which must be under operator control.

Phase II: This will require the final development of a digital signal processor which implements the findings of Phase I and is capable of extracting a signal with a negative signal to noise ratio.

A90-363   TITLE: Computer-Assisted Low Data Rate Driving for Military Applications

CATEGORY: Exploratory Development

OBJECTIVE: Design and develop a methodology to permit rapid deployment (at speeds of up to 20 kilometers-per-hour) of robotic vehicles, platforms and mission modules at distances of up to 4 kilometers using a low datarate (16 kilobits-per-second or fewer) video and communications link. Phase II system will permit the military operator to perform path planning, path designation, and execution of commands to the remote robotic system to traverse the chosen path.

DESCRIPTION: Currently, full-time operator-in-the-loop control is required for deployment of remote robotic vehicles. Remote driving of these vehicles can be automated through the use of computer-controlled path planning and execution programs. An additional complication is the requirement for use of a low datarate bandwidth to ensure secure communications and command and control on the battlefield. Current secure video links require that the operator attempt to drive using a very degraded image (the result of applying image compression techniques to reduce required bandwidth), resulting in very slow and inaccurate deployment. A technique is needed to allow an operator to view a remote scene (using the vehicle's on-board video), select a path to the next waypoint and command the vehicle to traverse terrain to that waypoint without requiring full-time intervention.

Phase I: Design and develop a technique for computer-assisted path selection, perform preliminary engineering studies and provide an engineering specification to implement it on an existing robotic vehicle or platform. Candidates include the HMMWV currently in use on the Army's Tech-Based Enhancement for Autonomous Machines (TEAM) program or other robotic platforms in use at the US Army Human Engineering Laboratory.

Phase II: Implement the final design onto two engineering prototype systems. The first implementation will use a small test platform (the size of a golf-cart or smaller) which can be used for controlled studies to test alternative soldier-machine interface designs for the command and control of military robotic vehicles, platforms and mission modules with the automated driving technique. The second prototype will use a full-size military vehicle or robotic platform and will be implemented using the Real-Time Control System (RCS) robotics programming methodology developed by the National Institute of Standards and Technology (NIST). The second prototype will be used for field testing of the command and control design.

A90-364   TITLE: High Dexterity Telerobotic End Effector

CATEGORY: Exploratory Development

OBJECTIVE: Development of a multi digit (three or more fingers) sensor equipped, telerobotic end effector testbed. The testbed will be used to develop control software necessary for the effective introduction of telerobotic manipulation in a variety of Army applications e.g. munitions handling, maintenance and recovery operations.

DESCRIPTION: The effectiveness of robot manipulators designed to perform hazardous or labor intense functions is substantially reduced by available end effector technology. While flexible multi-finger grippers have been designed for use in research environments their lack of mechanical robustness, low payload etc. precludes their use in research using real military workpieces. The objective of the proposed effort is to develop a robust, multi-digit, sensor equipped end effector incorporating computer control and man machine interfaces. This will permit use of the testbed in teleoperated and autonomous control regimes for selected gripping tasks. The emphasis of the SBIR effort is the development of a flexible testbed suitable for follow on research on tactile sensing, grasping strategies etc.

Phase I: Will review the requirement and prior relevant work yielding a preliminary design concept for the end effector, its computer controller, sensors (tactile, proximity etc.) and man-machine interface. Interface specifications to government owned robot manipulators and robot control systems will be developed.

Phase II: Will complete the design and develop a working testbed equipped with a body of control software which in conjunction with the man machine interface will provide an effective force reflecting mode of teleoperator performance. While software (other than that necessary for test) for real time autonomous control of the end effector will not be developed in the second phase, the sensors, interfaces, processors and development environment to facilitate this as follow on research will be provided as part of the Phase II deliverable.

A90-365 **TITLE: New Hybrid Materials for Ballistic/Laser Protection**

CATEGORY: Exploratory Development

OBJECTIVE: To develop improved laser and ballistic resistant transparent materials. Potential Phase III applications for these new materials include helicopter/aircraft canopies, ground/tactical vehicle windscreens and direct view optics.

DESCRIPTION: Conventional polycarbonate panels/structures provide adequate ballistic protection but afford no eye protection against incoming laser irradiation. Incorporation of dyes and/or reflective filters provides adequate laser protection but only against a limited number of specific wavelengths in the visible region. Innovative hybrid passive or active transparent optical systems incorporating new materials and technologies are needed. Proposals addressing either one of the following approaches will be considered:
1. Hybrid laser/ballistic resistance material systems effective against mid to high energy out of band lasers with ballistic protection comparable to or greater than polycarbonate.
2. Hybrid passive or active laser resistance/ballistic protection system for broadband low energy laser protection in the 400-1200mm region with at least 50% photopic transmission and optical density greater than 4 when laser irradiation is present, and ballistic protection comparable to or greater than polycarbonate.
    Phase I: Develop one or more hybrid transparent materials concepts and demonstrate feasibility.
    Phase II: Optimize and scale-up the most promising hybrid materials system demonstrated in Phase I. Develop a full scale prototype system for specific Army application and demonstrate effectiveness against laser and ballistic threats or provide end item for government test and evaluation.

A90-366 **TITLE: Fiber Optic Lay-up in Composite Structures for Imbedded Sensors**

CATEGORY: Exploratory Development

OBJECTIVE: Determine potential and compatibility of fiber optics as signal carriers in composite structures, such as airframes, wings or combat vehicles. Develop models for incorporation of optical fibers into composite structures and evaluation of the effects of processing on the integrity of the optical fiber. Potential applications include Nondestructive Evaluation (NDE) of structures with imbedded sensors.

DESCRIPTION: Various structural components of military equipment are subject to extreme stress and fatigue during operation. Many of these components are made of composite materials. Various nondestructive methods are used for periodic examination of the integrity of structural components such as aircraft wings, among them acoustic emission and ultrasonics. If imbedded sensors could be used to have a continuous feedback of information from numerous key stress points on the integrity of the structure, equipment failure could be more accurately predicted and avoided. Piezo-electric sensors, which change optical properties in response to strain or other environmental factors related to structural integrity, are viable. Transmission of this response through light pipes, optical fibers, to a remote on-board analytic device is proposed. The optical fiber, as well as the sensor, must be imbedded in the composite structure. Compatibility of imbedding the optical fiber within the composite structure during processing should address degradation of the optical fiber components subjected to the pressure, temperature and chemical environment present.
    Phase I: Develop a model for incorporation of optical fibers into composite structures for several processing methods used in military applications. Develop a model for evaluation of the stress, temperature, and chemical impact on the optical fiber during processing.
    Phase II: Demonstrate the validity of the model obtained in Phase I by fabricating sample composite structure incorporating optical fibers for one or more processing methods and evaluating the optical and mechanical integrity of the optical fibers. Sample structures and fabrication methods should be typical of Phase III Army applications cited in the Objective above.

A90-367 **TITLE: Engineered Ceramic Reinforced Ceramic Matrix Composites**

CATEGORY: Exploratory Development

OBJECTIVE: Develop engineered ceramic matrix composites to desired properties and structural shapes. The inherent brittleness and low impact resistance of monolithic ceramics makes their incorporation into components very difficult. Clever design approaches to components should be combined with equally clever engineering of the material itself to increase the amount of abuse that the component can function with prior to failure. Potential Phase III applications are heat engine components, wear surfaces and armor.

DESCRIPTION: Monolithic ceramics currently can be manufactured to low porosity, near net shaped components. Processing refinements have led to an increase in reliability of these components though in-service abuse often has a terminal effect on the component. Innovative engineering of the material is required to improve the resistance of fracture from wear and impact damage.

Phase I: Develop engineered ceramic matrix composites; particulate, whisker, fiber, woven; into a 2-D or 3-D structure. The matrix and reinforcement can be a boride, carbide or nitride based ceramics. The deliverable will be three separate compositions of two tiles 50 x 50 x 10 mm in size for property evaluation.

Phase II: During Phase II, the most promising composite combination will be scaled-up to produce 150 x 150 x 50 mm tiles and to show complex shape capabilities.

A90-368   TITLE: Unique Tungsten Based Composites and Heavy Alloys

CATEGORY: Exploratory Development

OBJECTIVE: Develop tungsten based composite or heavy alloys with unique alloy combinations in order to provide unusual mechanical or physical properties.

DESCRIPTION: It has been long known that pure tungsten, in the unworked condition, is brittle. It can be made ductile through extensive mechanical working or by alloying. The alloying efforts have generally concentrated on the class of alloys known as tungsten heavy alloys (generally W-Ni-Fe). Among other uses for the tungsten heavy alloys is kinetic energy penetrators, used for the defeat of armors. But, it is generally known that in most cases the heavy alloys are inferior to penetrators made from depleted uranium (DU) alloys. It is desirable at this time to investigate the development of a tungsten based composite or heavy alloy that is not based on the current heavy alloy system. Rather, the composite or alloy developed should take advantage of the high density and strength of tungsten but provide other mechanical or physical property advantages characteristic of the composite addition that would make a successful kinetic energy penetrator.

Phase I: The Phase I effort will define the composite, identify the contents of the various components, and demonstrate its fabrication. A preliminary effort should be made to show an improvement in the mechanical
properties, particularly the high strain rate properties (e.g. by hopkinson bar or other acceptable method of testing) of the composite over the current penetrator technology.

Phase II: The Phase II effort should optimize the composite composition and processing. An extensive property and microstructural characterization should be planned. Also, subscale ballistic test specimens should be produced in quantities sufficient to determine the ballistic properties of the composite.

A90-369   TITLE: High Temperature Oxygen Index Apparatus

CATEGORY: Exploratory Development

OBJECTIVE: Development of an apparatus capable of providing oxygen index (flammability/ignition) data at sustained temperatures from ambient to 800 degrees Centigrade on samples of polymer and composite materials.

DESCRIPTION: Organic polymers and composites are currently used as components of several military systems (ACAP, Bradley, CIFV). Increased usage in military applications is inevitable as they become more fire resistant and their cost-effective characteristics are better defined. Determination of the oxygen index, (OI), or minimum concentration of oxygen in a flowing oxygen-nitrogen mixture required to sustain equilibrium combustion (ASTM D2863-77), provides a means of ranking organic polymers and fiber-reinforced composites in terms of "ease of ignition", one measure of fire resistance. Research conducted, to date, clearly indicates that the ranking observed at ambient temperature seldom holds at elevated temperatures and that there is no known way in which ignition behavior between ambient temperature and the upper limit of measurement can be reliably predicted.

Phase I: Phase I should investigate the feasibility of an instrument operating at temperatures in the range 400-800 degrees Centigrade. The ability to actually measure OI values at these thermal levels, temperature stability under operating conditions, durability of instrument components, etc. should be demonstrated in this phase.

Phase II: Phase II should consist of the construction of an appropriate instrument for test and evaluation. Any modifications required after initial operation should be made during this phase of the program. Final result should be a completely operational instrument.

A90-370   TITLE: Low Cost Phased-Array Antennas

CATEGORY: Exploratory Development

OBJECTIVE: Successful development would make available low cost phase-array antennas for employment into communications/surveillance equipment for Army systems. This would offer users a versatile tool much as low cost microprocessors did to users of closed loop control systems.

DESCRIPTION: Phased-array antennas offer agility and high directionality at high cost due to manufacturing techniques and assembly costs. Multilayer thin film technology offers substantial cost reduction at some potential cost in agility and power handling capability. Material processing techniques exist which promise adequate performance for non-critical equipment. Emphasis of this work is to broaden the use of the technology by substantial cost reduction.

     Phase I: Consists of determining suitable fabrication techniques and methods which will allow low cost manufacture of suitably designed microwave phased-array antennas.

     Phase II: Consists of actual manufacture of an operating phased-array antenna based on the design developed in Phase I and the full engineering studies and data packages which demonstrate the low per item cost when scaled up to production runs.

A90-371   TITLE: Improved Thermographic Techniques for Composites

CATEGORY: Exploratory Development

OBJECTIVE: To develop optimal thermographic NDE techniques for field inspection of large scale composite structures. Potential Phase III applications for this new NDE technique include helicopter rotorblades and panels, primary aircraft structures, rocket motor cases, bridging components, bore evacuators, future combat vehicles, as well as commercial areas such as fixed wing aircraft, helicopters, and automotive.

DESCRIPTION: Numerous contact and noncontact thermographic NDE techniques have been developed over the last twenty years. Recent improvements in thermal imaging systems have resulted in renewed interest in real time thermography as a viable NDE technique for composites. However, practical experimental techniques employing these thermal imaging systems have not been optimized for practical inspection of large composite structures in the field. Proposed thermographic inspection system musts be environmentally safe and not affect
structural performance of the composite. Proposals addressing one or more of the following techniques would be considered:

     1. Low cost, preferably reusable, contact liquid crystal or other temperature sensitive materials or coatings.

     2. Optimized contact or noncontact passive thermographic technique incorporating a field portable uniform high intensity heat source and thermal imaging system.

     3. Optimized contact or noncontact active thermographic technique incorporating field portable vibrothermographic system.

     Phase I: Review and evaluate state-of-the-art thermographic methods for quality control and NDE of composites. Develop and demonstrate feasibility (analytically or experimentally) of improved integrated, thermographic techniques for inspecting large composite structures.

     Phase II: Select one or more of the most promising techniques addressed in Phase I and optimize. Develop complete integrated prototype field portable inspection system and demonstrate application on full scale composite structures used in Army systems.

A90-372   TITLE: Nondestructive Evaluation Method for Moisture in Composites

CATEGORY: Exploratory Development

OBJECTIVE: Development of a novel automated NDE system capable of rapidly determining amount and location of moisture in fiber reinforced organic matrix resin prepregs and composite structures. Potential Phase III military and civilian applications for this new NDE system includes inspection of primary and secondary structures for aircraft and ground vehicles.

DESCRIPTION: Fiber reinforced organic matrix composites are being used or proposed as primary and secondary structures for numerous military and commercial applications. The structural behavior of these advanced materials is known to be affected by in-service environmental conditions (humidity, temperature, etc.). Absorbed moisture causes the matrix to swell, lowers the glass transition temperature of the resin (plasticization), induces residual stresses and microcracking in the composite, and can irreversibly degrade the fiber/matrix interface. In addition, moisture in prepregs (caused by improper storage) can change the curing behavior and degrade the physical and mechanical properties of the fabricated composite. Because of the deleterious effect of moisture on the mechanical properties of organic matrix composites, there is a need to develop an automated, one sided NDE system for rapid determination of the amount and location of moisture in these materials. Technique proposed/developed must be practical and suitable for operation in a manufacturing environment or dept/repair facility and, preferably, in the field.

Phase I: Review state-of-the-art in NDE techniques for detection of moisture and its effect on physical/mechanical degradation of composites. Develop and demonstrate feasibility of a laboratory technique for detecting moisture in a variety of composite materials and structures.

Phase II: Develop optimized, automated, ruggedized prototype system addressed in Phase I. Demonstrate capability of the prototype NDE system to detect amount and location of moisture in composite prepregs and composite structures of interest to the U.S. Army.

A90-373 TITLE: Mixed Microstructure Enhancement of Fracture Toughness in Sintered Silicon Nitride

CATEGORY: Exploratory Development

OBJECTIVE: Development of a starting material which, upon sintering, would yield a controllable, uniform, fully dense material made up of a mixture of elongate (acicular) and equiaxed grains. Phase III applications for this material are in the area of high-toughness engine ceramics.

DESCRIPTION: Starting powders and sol/gels commonly used in silicon nitride ceramic production normally result in either a uniform grain morphology, or in uncontrolled mixtures of morphologies in which defects and weak phases limit material toughness. Microstructures incorporating both equiaxed and elongate grains provide enhanced toughness, but non-uniform distribution of the different morphologies results in property degradation. Mixing precursors of different morphologies is difficult, and post-mixing segregation often occurs. To produce reliable, cost-efficient silicon nitride engine ceramics it is desirable to develop a starting material which does not require mixing, will not segregate during handling, will produce a uniform microstructure with controllable amounts of acicular grains, and will not result in defects or weak phase (e.g., due to dopant accumulation).

Phase I: Explore methods which can produce a mixed-microstructure end-product as described above. Demonstrate enhanced fracture toughness.

Phase II: Successful approaches identified in Phase I will be optimized on the basis of end-product quality (fracture toughness, uniformity, reliability of method), cost, and simplicity.

A90-374 TITLE: Intermetallic Aluminide Powders for Injection Molding

CATEGORY: Exploratory Development

OBJECTIVE: Develop an inexpensive process for the production of pre-alloyed, ultrafine intermetallic aluminide powders for particle injection molding applications.

DESCRIPTION: Powders used for particle injection molding are desired, on one hand, to have low mechanical friction and high packing density so higher particle loading can be achieved; these are characteristics of a coarse powder. On the other hand, it is desirable that the injected powder be fine enough to fill the molding die very well so the molding of fine detail and complex shapes is achieved. Additionally, uniformly sized particles helps attain isotropic dimensional shrinkage. Solid state sintering of aluminides is difficult when using coarse powders due to the low diffusion rate in the ordered lattice and powder as fine as fine as practicable is needed.

The goal of this work is the production of pre-alloyed intermetallic aluminide powder with particle sizes finer than 20 microns. It is also a goal of this work that the process be inexpensive compared to current processes when large production quantities are considered. The technique must produce a high yield of powder in the desired size. The particle injection process also requires that the powder particles be approximately spherical to allow the removal of the binder so the processing technique should create powder of an appropriate shape.

Phase I: The Phase I effort will develop and define the powder production technique and demonstrate that the technique is capable of producing powder of the desired characteristics. An initial effort must be made to show an economic advantage to the process (ie. high powder yield at low material and energy cost and low capital cost compared to the life of the equipment).

Phase II: Phase II should scale-up laboratory sized equipment to a production level and demonstrate the production of high volumes of powder. A full engineering economic analysis must be performed showing that the process is cost competitive.

A90-375 TITLE: Innovative Life Cycle Management Systems for Composites

CATEGORY: Exploratory Development

OBJECTIVE: To develop an integrated, interactive Bar Code and database system for composite life cycle management. Potential Phase III applications include adaptation of this system to address other composite (and non-metallic) manufacturing programs at DoD installations and commercial facilities.

DESCRIPTION: Presently, no easy way exists to monitor and track materials through all the processes required to fabricate them into composite specimens and structures. An inventory of materials and their specifications must be available in order to assure shelf life and safety as well as processability. This computerized system must be easily accessible to all who choose to use it and be in a familiar format. Proposals should address development of an automated, interactive bar code and database management system that could be applied to composites tracking, characterization, fabrication and testing. Proposed system must be practical, readily adaptable, user friendly, menu driven and cost effective.

Phase I: Develop a viable concept for an integrated life cycle composite materials and structures management system. Describe advantages and cost effectiveness of this technology.

Phase II: Develop complete, automated, interactive life cycle management system (hardware and software) designed in Phase I. Fully implement and demonstrate this system on important Army Composite Programs to be identified during Phase I by the contracting agency.

Vulnerability Assessment Laboratory

A90-376   TITLE: Diagnostic Tool for High Power Microwave (HPM)

CATEGORY: Exploratory and Advanced Development

OBJECTIVE: To develop electric field sensor(s) which can measure the intensity and pulse shape of a HPM field without perturbing the field.

DESCRIPTION: The U.S. Army has extensive program for electronic warfare vulnerability assessments (EWVA) designed to stress development, developmental and next generation weapon/communication-electronic (CE) system to existing and postulated EW environments. One of the EW environment involves HPM. The effects of HPM on weapon/CE systems are being investigated. There is a need for an electric field sensor which can measure the intensity and pulse shape of a HPM field without acting as a perturbing influence on the field. The sensor developed should be capable of measuring field strengths of 10 to 1000 watts/sq.cm. and should operate over the frequency band from 100 megahertz to at least 10 gigahertz. The sensor should have no metallic components to perturb the electric field.

Phase I: Feasibility study to determine the technical viability and merit of the concept.

Phase II: Tangible results such as software, prototypes, etc. shall be developed to prove the feasibility of the proposed design. Proof of principle demonstration of the developed prototype shall be made.

A90-377   TITLE: Large Duty Cycle Pulsed Semiconductor Diode Lasers

CATEGORY: Exploratory and Advanced Development

OBJECTIVE: To develop pulsed semiconductor diode lasers with duty cycles greater than 0.4%.

DESCRIPTION: There is a need to research methods of constructing pulsed semiconductor diode lasers with duty cycles greater than 0.4%. Present day pulsed semiconductor diode lasers have 0.014% duty cycles within the emission wavelengths of 800 to 1100 nanometers. Typical pulse lengths and repetition rates are 100 nanoseconds and 1 kilohertz, respectively. The required pulsed semiconductor diode lasers with the larger duty cycle will be used in the construction of rail jammers for field and laboratory work. a Typical rail jammer might have a pulse length of 10 to 100 nanoseconds and a repetition rate of 50 to 100 kilohertz. Although present day diode lasers are small and rugged, their pulse lengths and repetition rates (i.e., duty cycles) are too slow to meet the requirements of a rail jammer.

Phase I: Theoretical study to determine the feasibility of developing a pulsed semiconductor diode laser with large duty cycles.

Phase II: This effort will result in the prototype development of a pulsed semiconductor diode laser with large duty cycle compatible for use with rail jammers.

A90-378   TITLE: Dynamic Scene Generator

CATEGORY: Exploratory and Advanced Development

OBJECTIVE: To design, develop and demonstrate the feasibility of dynamic multi-band scene generator

DESCRIPTION: A dynamic scene generator is required which will create an image of at least a 512 pixel scene to be used for testing a variety of sensor systems. The scene generator shall operate, not simultaneously, in two bands: long wavelength IR (8 to 12 microns) and mid IR (3 to 5 microns). It shall have a variable field of view (3 degrees to 20 degrees in 1 degree increments) and a dynamic temperature range of at least 20 db from a background ambient temperature of around 20 C. It

shall have a write/eraser capability that will allow viewing at least 30 frames/second with 100 frames/second preferred. It shall have a 0.1 C resolution using an 8 bit digitized input to represent the temperature of each pixel. The feasibility of projecting a scene can be viewed by a sensor system while meeting the aforementioned specifications shall be demonstrated. In addition, it is required that the scene generator be capable of projecting a scene in the UV (0.2 to 0.4 micron) and mmw (35 gigahertz 1/2 GHZ.) bands. The requirements for the dynamic scene generator will be set by the technological limits imposed by operating in the two bands (longwave IR and mid IR) and generating a 512 by 412 pixel scene.

Phase I: Study to determine the feasibility of a dynamic scene generator meeting the specifications stated above.

Phase II: Prototype of the required dynamic scene generator shall be developed. Proof-of-principle demonstration shall be made.

Aviation System Command

A90-379   TITLE: Avionics Combat Maintenance/Battle Damage Repair (CM/BDR)

CATEGORY: Exploratory Development

OBJECTIVE: Development of damage criteria for avionics due to conventional, nuclear, biological, chemical and directed energy environments. Investigation of repair requirements, concepts and techniques. Development of avionic Cm/BDR guidelines. Phase III is the actual implementation/demonstration of the guidelines.

DESCRIPTION: Deficiencies exist in developing BDR procedure for complex electronic equipment in Army helicopters. Today's helicopter avionic systems are more sophisticated than ever before and will continue to be complete in the future. With the advent of advanced integrated avionic architectures and dependence on AI/knowledge-based expert systems to handle more aircraft functions, more and more complicated electronic equipment will be installed on the modern helicopter. Indeed, electronics will enable Army forces to respond rapidly to the intense battle tempo future conflicts. Unfortunately the same electronics equipment that provides this force multiplier is very sensitive and highly vulnerable to damage.

Phase I: Problem Definition:
o Analysis of problem severity with respect to conventional, nuclear, biological, chemical and directed energy environments.
o Survey and evaluation of repair requirements, concept and techniques.
o Recommend BDR guidelines for development.
Phase II: Guidelines Development:
o Identification of maintenance repair requirements with respect to combat resilient designs, support equipment/tools, Army maintenance management structure and logistic support.
o Development of avionic CM/BDR guidelines/specifications.

A90-380   TITLE: Spatial and Temporal Registration of Dissimilar Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop a capability for spatial and temporal registration of dissimilar target acquisition sensors.

DESCRIPTION: Target acquisition systems are moving away from single to multiple sensor fusion systems. With this new technology comes several challenges, including the difficulty of spatially associating/correlating target reports from several sensor, and associated processor, sources while operating in an airborne platform. A further complication includes the temporal variation in target reports. For example, a radar scans the temporal variation in target reports. For example, a radar scans differently and more quickly than a FLIR, thereby generating target reports at different times. Determining the correct correlation on target reports from the two sensors is a complicated task, and multiple sensors is even more complex. Uncertainty regions, order of association, and determination of the final target position are all affected by the method of correlation. This effort is to look at the problem of spatially and temporally associating target reports from a FLIR, TV and Millimeter Wave Radar.

Phase I: The result of Phase I should be a defined approach for associating target reports, and a description of the required sensor performance, output parameters and processor requirements. This approach supported by analysis.

Phase II: Further development in Phase II, if warranted, should include a testing of the correlation approach using test data available from a previous multiple senr fusion field tests. The Phase II proposal should include a description of sensor parameters and target location and time of collection information required to fully test the approach to association.

A90-381   TITLE: Turboshaft Engine Surge Control

CATEGORY: Exploratory Development

OBJECTIVE: To design a system capable of avoiding an impending surge or smoothly recovering from an active surge on a turboshaft engine.

DESCRIPTION: Digital electronic engine controls are rapidly expanding the role of control systems in the normal operation of helicopter turboshaft engines. Controls are no longer limited to scheduling fuel flow versus a few environmental and engine conditions, but can now also be concerned with fuel economy at steady state conditions, torque, temperature and speed governing, and anticipation of transients in engine torque requirements. One area that requires increased investigation is the detection, recovery from an avoidance of surge. Aided by improved sensing devices which respond faster to transients in pressure and temperature, new control methods may be developed which will allow the engine variable geometry, thus circumventing the surge altogether. Also, in the unfortunate case that the engine actually undergoes a surge, a method to smoothly recover from it would be necessary. The engine system this surge control is to be designed for will be decided at a later date with the stipulation that it must be a turboshaft engine currently used by helicopters in the Army inventory or presently under development for use in Army helicopters. Any sensors earmarked for use by the control must already be developed, although not necessarily available on existing systems. The goal of this program is to develop a control system which will allow the engine to operate at the maximum possible level of performance, while actively detecting and avoiding impending surges, or in the case of an actual surge, to smoothly recover and transition back into normal operation. Once developed, the control will need to be evaluated through simulation and on engine performance testing.
    Phase I: Will generate a formal report which will include designs for a system that will satisfy the objective of surge control and a tradeoff analysis which shows how engine performance is affected by varying degrees of surge protection.
    Phase II: Will consist of fabrication of the surge control system complete with all necessary software and hardware (in breadboard form). System performance will be verified through engine simulation and on-engine testing. Phase II will generate a final report which will include all results of the performance tests.

A90-382   TITLE: Knowledge Base Development for Rotorcraft System Status

CATEGORY: Advanced Development

OBJECTIVE: Develop a knowledge base for a portion of the System Status for the Day/Night Adverse Weather Pilotage System (D/NAPS).

DESCRIPTION: The major objective of the D/NAPS program is to flight-demonstrate enhanced mission of effectiveness and survivability for day/night adverse weather operations through innovative integration of advance technology to include sensors, computing methods, and controls/displays. The D/NAPS program will demonstrate a representative set of capabilities which will enhance pilotage tasks (vehicle operation, communication, defensive system operation, crew/team coordination, navigation, and mission/tactical planning) during day/night adverse weather operations. The D/NAPS mission entails low-level, contour, and nap-of-the-earth flight to a destination within hostile territory while avoiding and/or surviving threats within a pre-specified arrival time window, and return to a friendly base with a specified probability of survival. The subject SBIR effort will augment the D/NAPS program as indicated below:
    Phase I: The Phase I effort shall culminate in a description of the knowledge base for a portion of the D/NAPS System Status, a software development plan, a D/NAPS interface description, and a test and evaluation plan.
    Phase II: The results of Phase II shall be verified software with a demonstrated capability in a software engineering environment to perform a portion of the D/NAPS System Status functions described as follows: The SS expert system shall be responsible for overall aircraft system resource configuration and shall reconfigure or change operation mode where applicable in the event of critical (mission affecting) equipment failures. The SS function shall maintain status information on aircraft sensors, processors and subsystems, performing fault diagnoses with built-in continuous self tests and developing plans for the diagnosis and prediction of critical failures. The SS function shall include sensor, processor and subsystem diagnosis and reconfiguration. It shall determine revised operational limitations based on system faults, failures, and malfunctions due directly or indirectly to combat damage and inherent failure. It shall determine revised operational limitations based on remaining expendable resources (fuel, flares, chaff, etc.). It shall present pilot caution/warning advisory and procedure information in event of an emergency, but shall execute automatic reconfiguration functions without the need of pilot intervention.

A90-383   TITLE: Magnetic Bearings for Gas Turbine Engines

CATEGORY: Basic Research

OBJECTIVE: Develop magnetic bearings which will replace conventional rolling element bearings in a two-spool gas turbine engine.

DESCRIPTION: Performance requirements on future gas turbine engines will place stringent demands on mechanical components; in particular, bearings and lube requirements. Magnetic bearings offer great potential for aerospace and industrial

applications where high temperatures (850oF-1500oF) and pressures restrict wet lubricant (e.g., MIL-L-23699 or MIL-L-7808) and dry lubricant (e.g., powdered MOS2) use. A need exists to improve the magnetic materials used in magnetic bearings. The magnetic strength of the magnetic material determines the bearing/s dynamic and static load bearing capability. Materials to be considered should have high potential for Phase II development/producibility such as rare-earth samarium-cobalts or iron-boron combinations. The bearing dynamic load capacity will be greater than 10,000 pounds, with static load capacity greater than 18,000 pounds.

Phase I: Phase I effort will involve selection of baseline turboshaft gas turbine engine and ball bearing performance parameters. A preliminary design will be executed to include the magnetic bearings, magnet material power requirements, microprocessor/controller, packaging, and software. Critical areas requiring future development will be identified for Task II.

Phase II: Development of the magnet material, fabrication of the magnet bearings, and final bench testing will include two bearings (each having four axis of control) suspending a rotating shaft).

A90-384   TITLE: Fast Activating Transparent/Opaque Device

CATEGORY: Exploratory Development

OBJECTIVE: To develop a dynamic laser eye protection window which is capable of activation from a transparent state to an eye safe state fast enough to preclude eye damage. The system must protect eyes from low energy laser hazards across the entire visible and near infrared spectrum.

DESCRIPTION: Currently laser eye protection for Army aviators is provided with dye absorbers or holograms embedded in helmet mounted visors. These static systems only protect against a limited number of fixed wavelengths, require a full time luminous transmissivity loss and add weight and complexity to the helmet. There are several DOD research efforts underway to provide eye protection against frequency agile low energy laser threat in the visible and near infrared spectrum. However, to avoid burdening the aviators with cumbersome eyewear, research efforts are required to develop a dynamic laser eye protection window concept which will provide inherent protection from frequency agile lasers. Dynamic filters are desireable, but have been limited by slow activation times. Innovative approaches are required to decrease the reaction times of laser protective devices to preclude eye damage.

Phase I: The desired result is a preliminary design for the fast activating transparent/opaque device. The actual device to trigger activation of the protection system will be developed under separate effort. Analytical and experimental efforts to assist in development and verification of the design will be required.

Phase II: This phase will encompass fabrication and performance evaluation testing of a fast activating laser protection system. Electrical signals can be utilized to trigger activation for demonstration and test purposes.

A90-385   TITLE: Long Life Catalytic Air Filter

CATEGORY: Exploratory Development

OBJECTIVE: To develop a catalytic conversion air filtration system for NBC protection of Army helicopters.

DESCRIPTION: There is currently a deficiency in the Army aviation arena of nuclear, biological, chemical (NBC) qualified aircraft. Rotary-wing aircraft must be able to operate and conduct missions in an NBC environment. The NBC threat exists and it is imperative that the Army be equipped to operate in this threat. Sufficient technology exists to filter contaminated air using carbon-based filters; however, numerous problems associated with the use of carbon filters still exist. Carbon dusting, unpleasant odor, and premature failure are just a few of the problems. However, the most significant drawback to these filters is the logistical supply burden they impose. Technology is mature enough today to develop catalytic conversion filters that will alleviate the majority of the aforementioned filter problems. Reducing these problems will allow for an aircraft qualified NBC filter, and consequently, and aircraft qualified NBC filtration system. NBC air filtration systems designed for helicopter application must be small, lightweight, durable and logistically supportable. Catalytic conversion systems could be promising if they can be shown to provide adequate protection for extended periods of time.

Phase I: The desired result is a trade study offering a description of an optimal material/configuration for the long life catalytic air filter concept.

Phase II: Development of a prototype system and testing with applicable chemical agent stimulants.

A90-386   TITLE: Digital Terrain Database Resolution and Accuracy Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Perform a tradeoff analysis using various Digital Map Agency (DMA) products and prototype products to determine the best combination of resolution and accuracy required for Army Aviation target acquisition purposes.

DESCRIPTION: Several existing and prototype DMA products offer digital terrain elevation data of varying levels of resolution and accuracy. Resolution refers to the grid spacing between sample points or posts and accuracy relates to the quality of the elevation information at that post. Projections indicate future Army Aviation assets will employ digital terrain elevation data within their associated target acquisition systems for passive ranging purposes. This effort is required to understand the effect different combinations of resolution and accuracy have on passive ranging performance. Consideration shall be given to the effects associated with overall target acquisition system errors (from the lock-on target reticle of the targeting display to sensor boresight), co-located sensor spacing, airborne drift (from registration within the digital map), and aircraft height above the terrain (low grazing angles versus high downlook angles).

Phase I: Data required to perform this analysis will be provided by the Government. This would include any known DMA products and prototypes, operational pop-up heights and typical aircraft target acquisition system accuracies. The Contractor shall be responsible for writing the analysis software, performing the analysis, and subsequently writing a report. The analysis software shall be deliverable under the contract.

Phase II: A follow-on effort is not anticipated at this time.

A90-387   TITLE: Advanced Fastener System for Composite Structures

CATEGORY: Exploratory development

OBJECTIVE: To develop a fastener system to optimize joining systems composite structures.

DESCRIPTION: Fasteners currently being utilized on composite structures are an outgrowth of the Sheet Metal Era. They do not interface well with composite materials. Advanced composites can be delicate materials to fasten. Ordinary fasteners can damage the fibrous composite panels when installed. Creating a hole in fibrous composite materials can cause delaminations to the back or blind side of the panel, whereas metal materials tend to deform slightly without seriously diminishing their load carrying capabilities. This could result in fastener pull through in the composite. The pressure required during installation can cause buckling or delamination, and the problems that occur during use include edge delamination, crushing, or pull through. Most metals are not compatible with the carbon fibers so common in advanced composites, and therefore run the risk of galvanic corrosion. Metal fasteners must be made of titanium alloys, austenitic stainless steels, or Inconel, metals that are the most compatible with advanced composite materials. Not only is there a problem about what fasteners can do to composites, there is also a problem of what composites can do to fasteners. Abrasive fibers damage unprotected fasteners during repeated installation and removal cycles. Other problems with the current fastener systems on composite structure are: corrosion from the non-composite fastener, fastener mechanical failures, nonstandardization of fastener sizes and lack of lightning strike grounding capabilities. Developing a viable fastener system which will reduce the large number of fasteners and be compatible with composites, will save weight and money on the Army's future aircraft.

Phase I: The desired results of the Phase I effort are to make a field evaluation and literature survey of current production fasteners and evaluate materials for the design of a new fastener system to interface with composite structure. Candidate fastener design materials will be evaluated and tested for interface requirements with advanced composite materials. Coupon test with the proposed fastener material will be conducted.

Phase II: The end result for this R&D program will include design, fabrication and test of an advanced application fastener system for composite aircraft structure. The selected system will represent an improvement over existing fastener systems in terms of acquisition and support costs and weight. The fastener system will be designed, fabricated and full-scale tested. The new fastener system will be tested with composite airframe structures for high and low cycle fatigue, environmental conditions to include temperature and humidity effects, and for static strength properties.

A90-388   TITLE: High Performance Fuel Injectors for Small Gas Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate advances in fuel injection, atomization, and dispersion using JP-8.

DESCRIPTION: Fuel atomization and droplet dispersion techniques significantly affect the overall performance of turboshaft engines. In addition, they effectively dictate the engine starting and high altitude relight capabilities. However, this program is exacerbated by the Army-wide conversion from JP-4 fuel to the more viscous and less volatile JP-8 fuel. A need exists for developing improved techniques for fuel injection, atomization, and dispersion of the fuel droplets for use in the Army's small high temperature rise turboshaft engines. The proposed design should provide excellent fuel atomization at light-off conditions, as well as at full-power conditions. The successful design will be directly applicable to near and/or far term designs of Army turboshaft engines. The primary benefits of this program will be improved atomization and mixing. Secondary benefits would be pattern factor enhancement and the resultant turbine nozzle durability improvements.

Phase I: A Phase I program should result in a concept demonstration. This could take the form of a small-scale experiment or a sound numerical analysis that demonstrates the potential for significantly enhancing the fuel atomization and the droplet dispersion.

Phase II: A successful Phase II effort would demonstrate the concept at full scale, illustrating the utility of the concept for applications of interest to the Army.

A90-389   TITLE: Aviation Target Simulation

CATEGORY: Exploratory Development

OBJECTIVE: Determine the feasibility and potential methods of developing a comprehensive target simulation capability that will support aviation target acquisition development programs.

DESCRIPTION: Current multispectral target acquisition development efforts require simultaneous field data collection under realistic terrain and climatic conditions of all sensors being considered in the system. This is not only costly but sometimes impossible to orchestrate. The ability to simulate target signatures in appropriate background conditions for sensors such as visible and near infrared television, forward looking mid and longwave infrared, millimeter wave radar, radar, acoustic, etc. would be a significant advantage in multisensor fusion development. The simulation needs to be adaptable to variations in sensor capability and must not only model representative target signatures but the clutter environment in which the signatures will be placed.

Phase I: The result of Phase I should be a review of existing modeling and simulation techniques for aviation targeting sensors, new approaches currently in development, and technically supported position on the feasibility of developing an integrated capability to represent target signatures and clutter in various spectrums.

Phase II: Further development in Phase II, if warranted, should result in a specific approach and program plan to develop such a facility. Detailed specifications of processing, hardware, space, power, and staffing requirements would be laid out. Technical substantiation of the proposed development methodology will be required.

A90-390   TITLE: Temperature Effects and Compensation Techniques for Amplitude Modulated Fiber Optic Sensors and Components

CATEGORY: Exploratory development

OBJECTIVE: This project shall conduct experiments to define the temperature dependence of optical fibers and connectors on the amplitude of light passing through them. It shall use this information to develop and test a methodology to compensate for temperature effects on an amplitude modulated (AM) optical signal.

DESCRIPTION: Amplitude modulated fiber optic sensors have been shown to be affected by large temperature variations such as those occurring in the Army aviation environment (-55 C to 135 C). The dual wavelength
technique was shown to be inadequate in compensating for such large temperature variations since temperature affects the propagation of each wavelength differently.

Phase I: The Phase I effort shall perform any experimentation required to define the temperature dependency of optical fibers and connectors as a function of wavelength. This information shall be used to develop a preliminary design for a technique which will compensate for large temperature fluctuations as well as fiber aging and other signal degradation phenomenon.

Phase II: The Phase II effort shall develop the compensation techniques proposed during the Phase I effort. A prototype model will be constructed and tested over temperatures ranging form -55 C to 135 C. The prototype shall be capable of being used with any fiber optic sensor using an AM output signal. It shall also be capable of withstanding the harsh military environment.

A90-391   TITLE: Knowledge Base Development for Rotocraft Mission Planner (MP)

CATEGORY: Advanced Development

OBJECTIVE: Develop a knowledge base for a portion of the Mission Planner for the Day/Night Adverse Weather Pilotage Systems (D/NAPS).

DESCRIPTION: The major objective of the D/NAPS program is to flight-demonstrate enhanced mission effectiveness and survivability for day/night adverse weather operations through innovative, integration of advanced technology to include sensors, computing methods, and controls/displays. The D/NAPS program will demonstrate a representative set of capabilities which will enhance pilotage tasks (vehicle operation, communication, defensive system operation, crew/team coordination, navigation, and

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mission/tactical planning) during day/night adverse weather operations. The D/NAPS mission entails low-level, contour, and nap-of-the-earth flight to a destination within hostile territory while avoiding and/or surviving threats within a pre-specified arrival time window, and return to a friendly base with a specified probability of survival. The subject SBIR effort will augment the D/NAPS program as indicated below:

Phase I: The Phase I effort shall culminate in a description of the knowledge base for a portion of the D/NAPS Mission Planner, a software development plan, a D/NAPS interface description, and a test and evaluation plan.

Phase II: The results of Phase II shall be verified software with a demonstrated capability in a software engineering environment to perform a portion of the D/NAPS Mission Planner functions described as follows: The MP expert function shall be based on the availability of preflight up-loaded, stored mission plans. The MP function shall provide a mission re-planning capability in response to unanticipated conditions or pilot commands. The MP function shall provide rapid path planning within mission constraints. A combination of heuristic and algorithmic methods is acceptable to provide good (though not necessarily optimum), quick options to the pilot. Both two-dimensional and three-dimensional path planning shall be considered and implemented. The MP function shall utilize aspects of both temporal and spatial reasoning. The MP function of resources as determined by the System Status.

A90-392   TITLE: Effectiveness of Active vs Passive Countermeasures

CATEGORY: Exploratory Development

OBJECTIVE: Develop an analytic code which defines optimum mix of active and passive countermeasures for rotorcraft given specific threat laydowns.

DESCRIPTION: If rotorcraft signatures are significantly reduced, the power required by on-board jammers can also be reduced. Performance, weight and cost are all factors in determining the selection of survivability enhancement features for rotorcraft such as the LHX. It is imperative that active CM Requirements be closely integrated with achievable, passive reduction levels. There does not exist currently, in industry or the Government, a code for this prediction. One has been needed for the LHX development and the LHX COEA. This project will develop an analytic code which considers given RCS and IR signatures for rotorcraft, given threat systems, given scenarios, given CM characteristics and then predicts effect of various combinations of signature/CM on survivability and mission effectiveness. The code will also optimize the required mix for a given scenario by adjusting signature and active CM parameters.

Phase I. Will provide a user friendly analytic code to predict probability of survival and mission completion for three specified scenarios. Deliverables will include a report on analysis results, documentation for the code, and a copy of the software.

Phase II: Will develop an optimization of the code to indicate CM requirements given signatures, and to indicate signature requirements given CM characteristics, for a wide range of possible scenarios. Deliverables will include documentation for the code, report on analysis results for several test cases, and a copy of the optimization code software.

A90-393   TITLE: Helicopter Obstacle Proximity Sensing System

CATEGORY: Exploratory Development

OBJECTIVE: To use existing collision avoidance technology to develop an obstacle sensor for Army helicopters.

DESCRIPTION: Current Army doctrine calls for nap of the earth flying with hover and pop-up/pop-down, or hover with elevated sensors and sights (AHIP). Pilots, while hover, tend to unconsciously pull up and back into the trees behind them. There currently exist numerous collision-avoidance systems; however, none currently exist for Army helicopters. The purpose of this program is to demonstrate the feasibility of a simple, compact, inexpensive ranging system suitable for helicopter collision-avoidance application.

Phase I: The proposer would examine existing ranging systems and either select one or modify one for use on an Army helicopter. The system must be capable of working in a 360 degree environment and be able to detect obstacle (trees, rocks, bushes, wires, etc.) encountered during a typical mission. The system must be capable of working with a variety of different blade lengths, from twenty - thirty feet and still maintain a discrete sensing range 5-10 feet with a one to three foot resolution. The system should be eye safe and cause no increase in aircraft detectability.

Phase II: The proposer shall take the ranging system and perform verification testing at both a system and subsystem level. This would include verification of subsystem feasibility before system integration and complete system testing for each range to verify linearity, resolution, and minimum/maximum range capability. The evaluation of the technical feasibility of the ranging system will be based upon factors such as performance, complexity, weight, and cost.

A90-394   TITLE: Embedded Fiber Optic Sensors in Composite Aircraft

CATEGORY: Exploratory Development

OBJECTIVE: To provide built-in inspection method for high performance composite structures.

DESCRIPTION: Current research in the area of bearingless main rotor hub technology on military helicopters shows promising benefits for using composites to improve structural life, cost and damage tolerance assessments. Many of the bearingless hub concepts use a composite flexbeam as the primary load transfer member between the rotor blade and the main rotor hub. These flexbeam structures have complex bending, axial and torsional loads imposed by the rotating hub and often they are enclosed in a pitch case which prevents easy visual inspection. The requirement exists for a ground-based structural diagnostic tool to test the structural integrity of such a structural component without having to remove the pitch case. Embedded fiber optic sensors have the potential for meeting this requirement by placing a fiber optic sensor in a structure during the fabrication process. These fiber optic sensors can then be utilized to improve damage tolerance detection as well as aid in the detection of impending structural weakness, permitting the structure to be repaired or removed before failure. Technical issues which require investigation include material and strain compatibility between the embedded fiber optic sensor and the host composite structure; the stresses that the structure experiences during the fabrication process; the accuracy, reliability, and life of the sensor device and sensor activation techniques. Testing of highly stressed laminated composite structures with embedded fiber optic sensors need to be conducted to correlate signal response to a number of laminate properties and verify that interference with the signal does not occur.
    Phase I: Investigate the type of fiber optic sensors available for the application of embedding the sensor in highly stressed composite components. Identify and select the processes which will be used to embed the sensor in the composite component. Define application range and identify problems which may occur during the fabrication process. The methods for embedding these devices need to be developed so that a structure can be produced in a timely and cost effective manner with minimal effect on structural integrity of the component.
    Phase II: Fabricate composite components with embedded fiber optic sensors. Conduct preliminary static and dynamic tests of components and monitor the performance of the fiber optic sensor. Develop techniques to assure that the devices and their associated input/output components are placed in the proper location without damage to the sensor. Provide a detail design of final product and list manufacturing steps and procedures. Calculate structural effects of a variety of embedding techniques in relation to the fabrication and manufacturing process. Conduct tests to correlate with analytical calculations. Develop a database detailing the effects of embedded fiber optic sensors on the structural integrity of the laminates.

A90-395   TITLE: Advanced Computational Fluid Dynamic (CFD) Code Development for Centrifugal Compressors

CATEGORY: Exploratory Development

OBJECTIVE: To further develop and validate an advanced (preferably 3-D fully viscous) CFD code for analysis of highly loaded, high mach number centrifugal compressors.
DESCRIPTION: Advanced CFD codes are a key to the development of high performance gas turbine engine compressors and turbine blading. This program is intended to take advantage of recent advances in CFD code development by converting such an advanced code to be able to readily perform the modeling or analysis of highly loaded, high mach number centrifugal compressors and accompanying diffuser systems which have a very complex internal flow. This code would then be used to analyze two previously designed and tested high performance centrifugal compressors and their code signed diffuser systems. The data for these compressors, which is necessary for their analysis, would be provide by the preparing activity listed below.
    Phase I: Phase I work performed shall involve the conversion of an advanced (preferably 3-D fully viscous) code, including boundary conditions set up to be able to analyze highly loaded, high mach number centrifugal compressors.
    Phase II: Phase II work will entail the analysis of the two previously tested centrifugal compressors mentioned above. This analysis will be performed in order to validate the advanced code and to further understand the flow fields of these compressors. This effort would also include some effort to analyze and recommend possible design changes for increased performance which are derived from the use of the developed advance code.

A90-396   TITLE: Knowledge Base Development for Rotorcraft Pilot-Vehicle Interface (PVI)

CATEGORY: Advanced Development

OBJECTIVE: Develop a knowledge base for a portion of the Pilot-Vehicle Interface for the Day/Night Adverse Weather Pilotage System (D/NAPS).

DESCRIPTION: The major objective of the D/NAPS program is to flight-demonstrate enhanced mission effectiveness and survivability for day/night adverse weather operations through innovative integration of advanced technology to include sensors,

computing methods, and controls/displays. The D/NAPS program will demonstrate a representative set of capabilities which will enhance pilotage tasks (vehicle operation, communication, defensive system operation, crew/team coordination, navigation and mission/tactical planning) during day/night adverse weather operations. The D/NAPS mission entails low-level, contour, and nap-of-the-earth flight to a destination within hostile territory while avoiding and/or surviving threats within a pre-specified arrival time window, and return to a friendly base with a specified probability of survival. The subject SBIR effort will augment the D/NAPS program as indicated below:

Phase I: The Phase I effort shall culminate in a description of the knowledge base for a portion of the D/NAPS Pilot-Vehicle Interface, a software development plan, a D/NAPS interface description, and a test and evaluation plan.

Phase II: The results of Phase II shall be verified software with a demonstrated capability in a software engineering environment to perform a portion of the D/NAPS Pilot Vehicle Interface functions described as follows: The PVI shall reduce pilot cognitive workload. The PVI shall adapt to changing cockpit conditions so as to be unobtrusive during low stress conditions and to provide maximum assistance in high stress situations. The PVI shall aid the pilot in an adaptive manner by monitoring pilot performance, comparing observed performance against expected performance, modifying pilot tasks as necessary to ease accomplishment, managing cockpit displays or formats to present only essential information at critical times, and performing automatically those functions required for mission success or survival. The PVI shall use advanced control and display technology which is available at the time of detailed system design. Pilot interactions with the system shall be as simple as possible and reconfigurable. The PVI shall provide for pilot challenge and system explanation of D/NAPS generated recommendations.

A90-397 TITLE: Lightweight Crash Resistant Fuel Tank Material

CATEGORY: Exploratory Development

OBJECTIVE: To reduce the weight of current fuel tank materials by 20% and still maintain the crashworthiness and self sealing capabilities required by the mil-spec.

DESCRIPTION: Current fuel tank materials which make up the fuel tanks used by the Army weigh approximately 0.9 lb/ft. These materials were developed in the late 60's and have been used by the Army since that time. The intent of this effort is to investigate new and improved lightweight materials which may be applicable to fuel tank materials which could reduce this weight.

Phase I: To identify possible materials to be used in the design and fabrication of fuel tank material. The materials selected will be based on their relative weight and strength properties as compared to the current materials used. A proposed lighter fuel tank material will be identified.

Phase II: To design, fabricate, and conduct tests on the fuel tank material design selected in Phase I against selected tests of the fuel tank mil-spec.

A90-398 TITLE: Portable Self-Powered Heating Tool

CATEGORY: Exploratory Development

OBJECTIVE: Develop a lightweight, portable, self-contained explosion-proof heating device for use on fueled aircraft to cure repair adhesives, composite materials and heat-shrink material (i.e. HTS hydraulic line repair fitting).

DESCRIPTION: In the future battlefield, battle damage repair will have to be performed in the field away from any air or power source. A lightweight, portable unit with its own power source that can deliver heated air (approx 350 degrees F) is needed to cure adhesives and shrink heat shrinkable material on fueled aircraft. Such a tool could be incorporated into the Army's aircraft battle damage repair kits to give maintainers flexibility in the types of repairs that can be performed. Without such a tool, the types of repair that a repairer can perform is limited by whether air or power is available and the time required to complete repairs are affected by availability of air/power sources.

Phase I: Design/Develop, fabricate and test a prototype tool that will meet the requirements for: portability, capacity (power and operating cycles/time), explosion-proof potential and cost.

Phase II: Engineering development of the tool to include: qualification testing, field testing, R&M testing, producibility engineering, and specification drawings.

A90-399 TITLE: Lightweight Electric Lube and Scavenge Pump

CATEGORY: Exploratory Development

OBJECTIVE: Design, fabricate, and test a compact, lightweight, reliable, electrically driven lube and scavenge pump assembly for use in gas turbine helicopter engines.

DESCRIPTION: Current gas turbine helicopter engine lube and scavenge pumps are driven by the engine through an accessory gearbox. This system contributes a large percentage to the weight of the engine, restricts flexibility for placement of accessories, and makes the speed at which accessories are driven dependent on the gas generator speed. The use of electrically driven accessories powered by an electric starter/generator is being investigated as a means of reducing accessory drive system weight, increasing flexibility of placement of accessories, and permitting operation of accessories at their optimum speeds for different conditions. However, most of the work has concentrated on the starter/generator portion of the system and very little has been done on accessories. In order to make the electric accessories approach feasible, compact, lightweight electrically driven accessories such as the lightweight electric lube and scavenge pump will need to be developed.

Phase I: Phase I of this project shall determine the requirements for the lube system for a gas turbine helicopter engine with electric accessories. Preliminary design of a self-contained pump assembly consisting of an electric motor and supply and scavenge elements shall be performed. The assembly shall utilize advanced materials and technology to minimize weight and volume. The effort shall include an investigation of the advantages and disadvantages of designing the unit to operate on 270 Vdc as compared to 28 Vdc. The assembly should be designed to operate under the environmental conditions specified by Mil-Spec-85734. Demonstration of a prototype electrically driven pump assembly is desired in Phase I.

Phase II: Detail design, fabrication, and testing of a pump assembly shall take place during Phase II. Testing shall demonstrate durability and debris damage tolerance of the pump assembly.

A90-400   TITLE: Modular Optical Delay Assembly for Digital Position Transducer

CATEGORY: Advanced Development

OBJECTIVE: To design and develop a fiber optic digital delay line and readhead module for use within one inch meter digital optical linear and rotary position transducers.

DESCRIPTION: A complete fly-by-light (FBL) flight control system has been developed and flight tested by the Army on a UH-60 helicopter under the Advanced Digital Optical Flight Control System (ADOCS) Program. The technology critical to FBL consists of basic fiber optic technology (crucial to communicating control signals throughout the aircraft) and sensor technology (crucial to generating the control signals). Government and industry have made substantial investments in basic fiber optic technology which has matured and is considered to be funded development programs, just recently matured to where producibility issues can be addressed. Current digital linear and rotary position sensors demonstrated in ADOCS are expensive to produce because hands-on labor intensive techniques, required to ensure adequate tension control of the fiber winds, are required to wind hair thin optical fibers around a mandrel (delay line assembly), which fits into the sensor body. Improper tension has a negative effect on sensor performance by producing excessive light loss in the fibers. This also increases the sensors sensitivity to temperature, since the fibers's tension varies as the mandrel expands and contracts with temperature. The current labor intensive manufacturing techniques are economically inefficient and cannot support production of the large quantity of sensors necessary for FBL control systems. Thus, this program will try to solve these problems as described in Phase I and II below.

Phase I: Design and develop a low cost, modular integrated fiber optic delay line assembly and transducer readhead, for a twelve bit digital optical linear position transducer. The design must be easy and relatively cheap to manufacture.

Phase II: Fabricate and performance test module prototypes; integrate them into a position transducer, and conduct system performance and life cycle tests.

A90-401   TITLE: Multimission Launcher Concept Development

CATEGORY: Exploratory Development

OBJECTIVE: The intent of this program is to develop a breadboard multimission launcher which is capable of firing all currently fielded U.S. Army Aviation missiles and to define associated logistical and technical advantages.

DESCRIPTION: Three missiles are currently fielded and operational within Army Aviation. These are the Tube-launched Optically-tracked wire-guided (TWO) and HELLFIRE air-to-ground antitank missiles and the Stinger air-to-air missile. Each missile has its dedicated launcher, interface electronics, and controls. Therefore, substantial logistical and operational benefit may be derived by developing a single launcher capable of firing all missiles. The intent of this program is to develop a missile launching system capable of firing and controlling HELLFIRE and Stinger only.

Phase I: The desired results of the Phase II are to assemble and test a breadboard Multimission Launcher in a laboratory environment using missile emulator hardware for functional verification.

Phase II: The desired results of Phase II are to assemble and test a breadboard Multimission Launcher in a laboratory environment using missile emulator hardware for functional verification.

A90-402   TITLE: Integrated Fire and flight control (IFFC) Implementation Assessment

CATEGORY: Exploratory Development

OBJECTIVE: Perform a preliminary qualitative feasibility assessment of the utility and implementation of Integrated Fire and Flight Control.

DESCRIPTION: To maximize the combat effectiveness of air-to-air rotorcraft, the control laws require specific tailoring to suit the mission. The new, emerging air-to-air requirement imposes demands on the rotorcraft and crew that exceed conventional design and handling qualities criteria. The purpose of this work is to explore the potential impact IFFC could bring to mission performance and to recommend integration methods/schemes/approaches to most effectively employ the IFFC concept in the modern attack helicopter.
    Phase I: The contractor shall perform a qualitative assessment of the implementation of an IFFC system/concept. The contractor shall further recommend integration methods/schemes/approaches to most effectively employ the IFFC concept in the modern attack helicopter.
    Phase II: The contractor shall define preliminary mission task tailored integrated fire and flight control law architecture for improved flight path precision for aerial gunnery. These mission "tuned" and fire control integrated flight control laws shall be structured to alleviate or mitigate fire control inaccuracy contributions from weapon firing-induced aircraft deviations or flexures during the gunnery task. The Contractor shall compose math models to quantify IFFC measures of effectiveness in simulation.

<center>Construction Engineering Research Laboratory</center>

A90-403   TITLE: Large Space Structure Design Parameters

CATEGORY: Basic Research (Engineering)

OBJECTIVE: To provide research solutions that identify the efforts of design related parameters on the stiffness and stability of large space structures in low earth orbit.

DESCRIPTION: Potential utilization of large space structures (assembled or deployed on orbit) by the Army as reverence platforms/supporting structures for arrays of sensors and their ancillary equipment will emphasize stiffness and shape stability in the space environment. Methods of design and analysis are needed to maximize these features while minimizing mass. The full interaction of structural configuration, materials and controllers will be considered.
    Phase I: The results of this phase will be a report which describes in detail design/analysis techniques, effects of materials properties and control systems needed for stiffness and shape stability in low earth or geosynchronous orbits.
    Phase II: Based on predictions of Phase I, this phase will develop a design model, create a hypothetical space platform that demonstrates high stiffness and shape stability, analyze/refine the model and produce a prototype large space structure of one-quarter scale or larger, for delivery to the monitor of the studies.

A90-404   TITLE: Lead Immobilization Coating/Treatment

CATEGORY: Basic Research

OBJECTIVE: To develop a potable water compatible chemical complexing agent which will selectively coat the residue from lead solder joints in drinking water plumbing, without physical removal of the pipes/soldered joints.

DESCRIPTION: The latest amendments to the Safe Drinking Water Act propose major reductions in allowable lead concentrations. The principal source of lead is solder in building plumbing systems. Although the use of lead solder has recently been banned, it is expensive to remove soldered joints from existing buildings. If a method to selectively coat and immobilize the lead in soldered joints were available which did not adversely affect the water quality, it would be a great benefit for lead control at existing buildings.
    Phase I: Investigate the ability of chemical coatings compatible with potable water quality guidelines to immobilize lead from lead soldered joints in a plumbing system. The most desirable methods would be chemicals which could be added directly to water. A second alternative would be a treatment applied while the system is temporarily taken out of service, followed by a flushing period after which the lines would be usable for potable water.
    Phase II: Develop and pilot test a Lead Mobilization Coating/Treatment System on a variety of existing buildings which exhibit high lead concentrations.

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A90-405   TITLE: Development of an Improved Rapid Seismic Analysis Procedure (RSAP)

CATEGORY: Exploratory Development

OBJECTIVE: Modify the existing RSAP to take advantage of recent advances in earthquake engineering and computer technology.

DESCRIPTION: A first generation Rapid Seismic Analysis Procedure (RSAP) is now outlined in the Tri-Service manual, Army TM 5-809-10-2, Seismic Design Guidelines for Upgrading Existing Buildings. This method is used to estimate potential earthquake damage to buildings. It is extremely limited in its ability to provide accurate and detailed results, and does not incorporate many of the lessons learned from recent earthquakes or recent developments in micro-computer hardware and software capabilities. With these recent developments and lessons learned, more detailed, accurate, and efficient methods of evaluating the earthquake resistances of structural systems of buildings are now possible. An improved Rapid Seismic Analysis Procedure should be produced based on these technical developments. Using this improved method RSAP, the vulnerabilities of military facilities to earthquakes may be more accurately and rapidly assessed without additional cost.

   Phase I: An algorithmic approach and basic concept for an improved RSAP shall be developed. This procedure shall incorporate the latest advances in earthquake engineering and computer systems engineering to assess the earthquake resistance provided by a building structural system. The procedure shall permit the analyst to examine a variety of construction materials and structural configurations, representative of conventional military construction, and shall permit the input of ground motion data as outlined in TM 5-809-10-2.

   Phase II: A micro-computer version of the improved RSAP shall be provided which allows engineers to rapidly and accurately assess the earthquake resistance of building structures. The RSAP software shall be verified through field application at a variety of military installations to be chosen by USACERL. The installations will reflect different building types and seismic inputs.

Cold Regions Research and Engineering Laboratory

A90-406   TITLE: Total Pressure Measurements in Freezing and Thawing Soils

CATEGORY: Exploratory Development

OBJECTIVE: To provide research and development resources sufficient for a small business contractor to develop to a marketable degree an instrumentation system for manually or continuously and automatically measuring and recording vertical and/or horizontal pressure beneath the surface of freezing and thawing soils.

DESCRIPTION: Currently available instruments are large and average the applied pressure over a large area. The devices were developed for use in large embankments such as dams or high retaining walls. In this instance it is desirable to develop a much smaller instrument which can be used beneath a road or airport pavement to determine the pressure at a selected "point".

   The currently-available instruments are generally very "stiff" or very "compliant" and tend to concentrate or more widely disburse loadings causing inaccurate data to be obtained. Matching the modulus of the gage to that of the soil is necessary to minimize these problems, but in seasonal frost areas the modulus varies substantially depending upon whether the soil is frozen, thawing, thawed and not reconsolidated or thawed and reconsolidated. The modulus of fine-grained soil may easily change three orders of magnitude during various stages of freezing and thawing.

   The ideal gage will be small, perhaps two inches in diameter by less than an inch thick, insensitive to temperature changes in the range of 0 F to 80 F, capable of measuring pressures in the range of 0.5 to 100.0 psi with a resolution of 0.1 psi and an accuracy of + or - 0.2 psi over the lower quarter or one-half of the pressure range and not more than + or - 0.5 psi over the upper one-half of the range.

   The instruments would be imbedded into soils ranging from granular base courses to silt and clay subgrades. The environment may range from saturated to very low degrees of saturation (20% to 30%) and road salts or other chemicals may be present occasionally or continuously in the soil. The most important environment change will be freezing and thawing, however.

   Phase I: a) Determine feasibility of instrumentation to meet the above standards.

            b) Develop a working "breadboard model" of instrumentation which will meet the requirements listed above.

            c) Conduct laboratory tests to verify the proper performance of the "breadboard model" instrument.

   Phase II: The contractor will design and fabricate a prototype of the equipment evaluated in Phase I. The end product will be a validated and calibrated prototype instrument which will be used in field experiments to demonstrate the potential applications in its intended environment.

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A90-407 TITLE: Development of a Portable Instrumentation-Video Interface

CATEGORY: Exploratory Development

OBJECTIVE: To provide research and development resources sufficient for a small business contractor to develop and successively market instrumentation ranging from a portable battery operated instrumentation interface system to an instrument with a minimum of four external sensors and overlay the results of that instrumentation on a video signal.

DESCRIPTION: Current technology allows for computer data to be overlayed one standard NTSC composite video signal. However, with the increased use of portable battery operated video recorders there is presently no technique to place data such as temperatures, wind speed, wind direction, etc. on the video recording. Many cameras have hand operated character generators built into the cameras for time/data and titles, but this does not input other instrumented signals on a real-time basis.

The instrumentation/interface should be small enough to be carried while operating a portable video system. The self contained battery should operate the instrumentation and generate the combined composite video signal for a minimum time of 2 hours when the ambient temperature reaches -40 C. The video input should be capable of accepting standard 10 pin, 12 pin, and 14 pin connections used by video manufacturers such as Sony, Panasonic, and JVC. The instrumentation input should be programmable to accept a diverse range of inputs, such as thermocouples, thermistors, wind speed, wind direction, strain gage load cell outputs, and other voltage or resistance type sensors. The programming can be comparable to an EPROM.

The interface should be capable of changing the color, contrast, and location of the four channels of sensor output on the composite video signal.

Phase I: a) Determine the feasibility of instrumentation to meet the above standards.

b) Develop a working model of the instrumentation/interface.

Phase II: The contractor shall design and fabricate the equipment evaluated in Phase I. The end product will be a validated prototype instrument to be used in field documentation of ice problems on rivers.

Engineer Topographic Laboratory

A90-408 TITLE: Dynamic Tactical Decision Aids (TDA)

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop new and innovative Dynamic Tactical Decisions Aids using advanced technology adapted to the needs of the non-technical military user.

DESCRIPTION: Past demonstrations of Tactical Decision Aids (TDA) during military exercises have demonstrated the need for more effective means of training a Geographic Information Systems (GIS) user to successfully generate and manipulate these TDAs. Frequently, the soldier has little or no experience in terrain analysis or computer methodology when he is assigned to a terrain unit and must be rapidly trained to perform this job. TDAs are created by a laborious process and produce a static output that cannot be manipulated by the user.

Phase I: The first phase will research new and innovative tools, hardware and/or software, to determine how these impact the creation and manipulation of TDAs. The tools could be incorporated within a GIS or applied within an independent frontend. Possible candidates for research would be touch screens, voice recognition devices, natural language or expert system interfaces, and hypercard/supercard technology. The result of Phase I will be a report itemizing the recommendations along with the system(s) (Macintosh, SUN, UNIX, S-Windows, etc.) to which the technology is adaptable.

Phase II: The second phase will demonstrate the usefulness of selected tools recommended under Phase I. The contractor will purchase the necessary hardware/software items, install them on a hardware system and GIS, prepare a formal demonstration, test the effectiveness of the project, and document the results.

A90-409 TITLE: Urban Warfare Digital Data Base

CATEGORY: Exploratory Development

OBJECTIVE: To develop an innovative concept and technique for generating topographic data bases

DESCRIPTION: Historically, by doctrine, the Army has avoided military operations over urban terrain. The past decade has clearly shown that not only is that approach not reasonable, but any high probability low intensity conflict will involve considerable fighting in urban areas. The recent fighting in the Philippines, Romania and Panama clearly show the tendency for urban areas to become the battleground of the future. The ability to create a topographic database for high resolution aerial photography over urban areas is very limited and largely a manual process. Those automated procedures that do exist, to extract evaluations to provide a topographic database, in a crisis response time frame, is badly needed. At a minimum, a wire

frame model, over which high resolution aerial photography could be draped is required. More sophisticated data bases showing the position of roads, buildings, and associated descriptions would be highly desirable.

Phase I: Provide a conceptual design and ETL laboratory demonstration of a methodology to generate an urban area topographic data base from high resolution aerial photography using a crisis scenario. The methodology is to be clearly documented including all relevant mathematics. Software is to demonstrate any high risk procedures. A wire-frame model over which the high resolution aerial photography can be draped is required as a minimum. More sophisticated databases showing the location of roads, buildings, associated descriptions would be highly desirable.

Phase II: Develop and deliver to the Government a developmental model with appropriate documentation for evaluation using live data. The entire process from photogrammetric source to a digital topographic data base (consisting at a minimum elevations but preferably feature data as well) will be evaluated. Follow-on work will be required in two areas. One will be to make the software more robust. The second would be to convert what is essentially a research piece of software to a prototype system which could be demonstrated with troops during field exercises.

A90-410   TITLE: Brigade Level Hardcopy Device

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to successfully develop a hardcopy printing device, used with a man-portable computer, to produce terrain analysis graphics in the field.

DESCRIPTION: The U.S. Army Engineer Topographic Laboratories is currently investigating the use of a small man-portable computer for use in preparation of terrain analysis products in the field, at brigade level and below. The computer is equipped with a single color plasma display, 8.5 by 6 inches in size. This is used to display various graphic products, but a hard copy printer capable of producing map overlays from the screen image would greatly increase the utility of the system. At present, there are no known hard copy imaging devices wholly suitable for this use. Such a device should be man-portable, capable of printing o transparency materials with a format at least as large as the display screen, use non-smearing inks, and be rugged enough for field use.

Phase I: The first phase of this project shall consist of: (1) a determination of the functional requirements for a Brigade Level Hardcopy Device, (2) an assessment of the applicable state-of-the-art within government and industry, and (3) an implementation plan acquiring or developing the device.

Phase II: A candidate printer will be procured and modified, or developed. It will be interfaced to and tested with the portable computer system.

A90-411   TITLE: Sensors and Technology for Minefield Detection from Space

CATEGORY: Basic Research

OBJECTIVE: Objective is to identify sensors and technology(s) that have the potential to be employed to remotely detect landmines from space. Parametric analysis would be performed to evaluate the potential for use of current and future sensors and technology(s) by the Army to detect landmines from space.

DESCRIPTION: Remote landmine detection is essential to minimize losses of Army personnel and equipment and facilitate rapid movement. This analysis would identify the kind and type of sensors and technology that could be employed from space to remotely detect landmines. This analysis would consider all sources of remote landmine detection including from personnel on the ground, ground vehicle mounted (manned or unmanned) and from manned and unmanned aircraft. The utilization of a space-based detection capability would be a compliment to those capabilities and not be a replacement, unless a space-based capability were far superior to other detection sources.

Phase I: Identification of performance parameters required for remote landmine detection from all possible detection sources (ground, air and space).

Identification of current sensors, technology(s) and/or a system(s) that are capable of detecting landmines from space, Identification of high payoff, future sensors, technology(s) and/or system(s) that require further development to accurately detect landmines from space.

Conduct a parametric analysis of the current sensors, technology(s) and system(s), high payoff, future technology(s) and system(s), and performance parameters required with the objective of identifying the contribution that space-based landmine detection can make to landmine detection from all possible detection sources.

Recommendations for development programs(s) to mature high payoff, future sensors and technology(s), if current technology inadequate, to accurately detect landmines from space.

Phase II: Conduct either an exploratory development or technology demonstration program to mature and demonstrate the high payoff sensors and technology(s) identified during Phase I above.

A90-412   TITLE: Development of a Statistical Method for Three-Dimensional Terrain Elevation Error Analysis

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop a set of measurements of the accuracy of Digital Terrain Elevation Data (DTED), a method for deriving the measurements, and a technique for evaluating the reliability of products derived from the data.

DESCRIPTION: Little is known about DTED accuracy, and consequently its reliability, yet DTED is essential for making most of the terrain analysis products employed by the field commander to make informed tactical decisions. A statistical method must be developed for measuring DTED accuracy in all three spatial dimensions.
    Phase I: Phase I will establish a rectangular array of highly accurate field elevations of positions contained in an existing DTED cell. With the field data as an experimental control, a mathematical method for analyzing DTED accuracy in three dimensions will be developed. A graphic display capability will be developed to visually demonstrate discrepancies found between DTED and the control data.
    Phase II: Phase II will demonstrate the methodology on DTED representing different types of topography. The tests will be used to validate the applicability of the measurements and the ability of Army users to apply the proposed evaluation techniques.

A90-413   TITLE: Development of Models for Terrain Features on Digital Radar Imagery for Automated Feature Extraction and Change Detection

CATEGORY: Basic Research

OBJECTIVE: The objective is to develop models in support of the automated extraction and change detection of significant military terrain features from digital radar imagery. Develop quantitative characteristics of the features, techniques for the separation of features from backgrounds, and strategies for effective and efficient automated feature extraction and change detection.

DESCRIPTION: Feature extraction and change detection from radar imagery cannot be accomplished timely and efficiently because it is performed manually by image analysts. This deficiency can be removed by automation. Radar signatures of terrain features very significantly with respect to the radar system parameters, imaging geometry and geographic locations. Hence, a feature may produce many different radar signatures. This fact presents technical barriers to automated feature extraction which may be resolved by the introduction of symbolic features and their radar signatures similar to the way that human analysts image signatures to specific features. The classification of the work will be SECRET. The developed software must be demonstrated on an ETL SUN or an equivalent work station using the C programming language and the UNIX operating system.
    Phase I: Detailed description of approach and methodology for symbolic model development and extraction demonstration for at least one feature from different radar images.
    Phase II: Symbolic models for relevant military terrain features, algorithms and software, and demonstrations of feature extraction and change detection on an ETL SUN or an equivalent work station.

A90-414   TITLE: Impacts of Climate Change

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to cull the current research related to global climate change, assess the forecasted impacts of climate change on the military and its activities (with special focus on the Corps of Engineers), and develop a plan of action and sets of recommendations to allow the military to effectively cope with and plan for these anticipated negative effects.

DESCRIPTION: The subject of climatic change is currently an extremely topical issue. A great deal of scientific activity is currently underway which focuses on such concerns as global warming, the Greenhouse effect, changing weather patterns, ozone depletion, etc. Various government and private agency experts have come forth with scientific prognostications concerning both short- and long-term climatic changes and
effects. However, the experts are not of one mind, as extremely conflicting and diametrically opposite points of view surface almost daily.
    With regard to the military, any major change(s) in the world's climate could have significant impacts. For example, changes in precipitation patterns, frequency of droughts, and the migration of major agricultural regions could generate new military alliances and may create new areas of potential military conflict. On its Civil Works side, the Corps of Engineers (COE) could be faced with increased shoreline erosion, inadequate dams, aqueducts, levees, piers, canals, etc. To adequately

prepare for such events, the military requires a knowledge base of current scientific climatic change information with associated impacts.

Phase I: Phase I will consist of a thorough and comprehensive literature survey of the most scientific climate change information and thinking. This survey will include detailed descriptions of models, algorithms and techniques, as well as summaries of findings to included type of change, magnitude and projected time scale of events. Potential impacts on the military and its activities shall be correlated to these findings in a general fashion.

Phase II: Phase II will expand upon the aspects of climate change as it relates to the military, with particular emphasis on the Civil Works arena of the Corps of Engineers (COE). Possible impacts on existing and planned COE structures, activities and procedures shall be examined in detail. When possible, cost estimates of these potential impacts shall be put forth. Potential solutions and planning guidance shall be recommended.

Waterways Experiment Station

A90-415   TITLE: Penetrating Sealants

CATEGORY: Explanatory Development

OBJECTIVE: The objective is to develop a penetrating sealant that when applied to concrete will penetrate at least to a depth of 18 in., restoring the integrity of unsound or deteriorated concrete and preventing additional deterioration. This is the typical depth of many concrete slabs for pavements and, where the concrete is often limited to the near-surface 18 in. of concrete. The development of the sealant may also require development in application procedures to ensure good, even penetration of the sealant into the concrete.

DESCRIPTION: Current sealants are only surface-type sealants, have limited penetration ability, and generally do not have the ability to reduce the migration of water in the concrete except at the near-surface region where they are applied. The new sealant should have good penetrating power, thus reducing the water permeability of the overall concrete to some depth approaching 18 in.

Phase I: Develop candidate materials.
Phase II: Develop candidate application procedures and test overall system.

A90-416   TITLE: In-Situ Test Device to Determine Lateral Earth Pressures

CATEGORY: Engineering Development

OBJECTIVE: Geotechnical investigations required for the design of structures and foundations for military operations, ground shock calculations, or studies of the mobility of wheeled and tracked vehicles, require a knowledge of in-situ stresses for initializing the computations. The technology to measure these stresses does not exist. Although vertical stresses can be estimated with reasonable accuracy from a knowledge of the unit weight of the soil, horizontal stresses must be estimated from the product of an assumed value or values for the coefficient of lateral earth pressure and the estimated values of vertical stress. Consequently, there is an inherent degree of uncertainty in these analyses. The Department of Defense has a critical need to develop the technology to determine horizontal stresses in situ. Successful implementation of this technology will have a direct application to the measurement of vertical stresses in-situ.

Phase I: The proposed research should include a literature search and an assessment of existing technology, preparation of conceptual design alternatives, development of an analytical model to assess design alternatives, an instrumentation requirements , and a summary evaluation of preliminary design criteria and instrumentation requirements, and a summary evaluation of the overall feasibility of the proposed project.

Phase II: The proposed research should included the design, fabrication, assembly and calibration of the test apparatus, laboratory or field in situ validation tests of the apparatus in cohesive and cohesionless soils, and a final report documenting the study.

Medical Research Acquisition Activity

A90-417   TITLE: Cross Sectional Imaging System Using Phosphor Transducers

CATEGORY: Exploratory Development
OBJECTIVE: Develop a volumetric medical diagnostic imaging device using photosensitive phosphor plate technology as a transducer. Conventional image processing algorithms (e.g. filtered back projection) should be used to render an image in digital format.

DESCRIPTION: The military medical services are interested in applying volumetric imaging techniques to combat casualty care. Phosphor plate technology may prove to be a reliable image transducing media to convert patient-attenuated x-ray photons into a diagnostically useful image.

Phase I: Explore design features, develop a proposed design with related engineering/physics data to support the technical approach.

Phase II: Develop a prototype breadboard device.

A90-418   TITLE: Purification of Native and Recombinant Flavivirus Proteins for Use in Vaccine Development

CATEGORY: Exploratory Development

OBJECTIVE: To purify native flavivirus proteins (E and NS1) for comparison with expressed protein vaccine candidates.

DESCRIPTION: The incumbent will grow large quantities of dengue and Japanese encephalitis viruses in tissue culture and purify native and recombinant proteins by the least denaturing techniques available. The purity of preparations will be at least 95% as demonstrated by polyacrylamide gels electrophoresis. The identity of proteins will be established using hyper immune ascitic fluids and monoclonal antibodies provided by Walter Reed Army Institute of Research (WRAIR). Gram quantities of proteins will be provided to WRAIR investigators for use as controls in mouse protection experiments.

Phase I: Bulk quantities of viruses will be prepared. Methods for purification will be developed using dengue-2. The envelope and the non-structural protein (NS-1) will be purified and characterized and their identity certified at WRAIR.

Phase II: Following determination of techniques, 50 gram quantities of each of the E and NS1 proteins of dengue-1 through dengue-4 and Japanese encephalitis virus will be produced and provided to WRAIR.

A90-419   TITLE: Development of Small Animal Infection/Protection Model for Dengue-3 Virus

CATEGORY: Exploratory Development

OBJECTIVE: Development of a small animal infection model for dengue-3 virus to assess the protective capacity of dengue-3 sub-unit and whole virus candidate vaccines.

DESCRIPTION: A reliable protection model to assess the protective capacity of dengue-3 virus antigens is currently unavailable. Dengue-3 viruses, members of the family Flaviviridae, are major public health threats in the tropics, causing epidemic and endemic disease. Candidate vaccines being developed include live attenuated virus strains, sub-unit preparations using protein antigens prepared by recombinant methods, or synthetically prepared polypeptides. The development of protective candidate vaccines would be enhanced by early evaluation in immunologically competent small animals. Small animal infection models already exist for other dengue viruses (dengue-1, 2, and 4) in weanling and young adult mice. No dengue-3 virus strains have been devolved which can infect mice older than about 12 days.

Phase I: Develop dengue-3 virus strains which can reliably infect young adult mice or a similar small animal model. Mouse neurotropic dengue-3 virus (for suckling mice) will be provided by the Government. Other strains will be provided if necessary. This work will be performed in close coordination with inhouse investigators at the Walter Reed Army Institute of Research.

Phase II: Develop protection assay to assess the immunological potential of selected dengue-3 antigens (provided by the Government) using the infection model developed in Phase I. The contractor will assess the protective capacity of the selected antigens and report on their immunological potential.

A90-420   TITLE: The Molecular Biology of the Mechanisms of Antiparasite Drug Action and Resistance

CATEGORY: Basic Research

OBJECTIVE: The project objective is to gain an understanding of the molecular basis of drug resistance in parasites. These data will be used to evaluate and develop novel chemical agents for combating drug resistant parasites.

DESCRIPTION: The utility of current chemotherapeutic drugs for the treatment of malaria, leishmaniasis and schistosomiasis is becoming less effective due to drug resistant parasites. In order to develop or adapt drugs whose efficacy is not compromised by this resistance, the molecular biology of drug resistance needs to be full elucidated. Data have suggested that multi-drug resistant protein, p-glycoprotein 170 (pgp 170), may facilitate drug efflux. Additional data is needed on the structure of transport protein(s), the mechanism of drug efflux, and the identification and characterization of the gene(s) involved.

Phase I: The identification and characterization of multi-drug transport protein(s) and gene(s).

Phase II: The development of drugs that will modulate the multi-drug resistance phenotype and the use of Phase I data to empirically ascertain the phenotype of drug-resistant parasites.

A90-421   TITLE: Development of Diagnostic Probes for the Detection and Surveillance of Drug Resistant Parasitic Infections

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop probe(s) that will provide rapid identification of drug resistant Plasmodium falciparum malaria and Leishmania species.

DESCRIPTION: The phenomenon of resistance to drugs by prokaryotic and eukaryotic pathogens is a matter of great practical concern. The prevalence of multidrug resistant strains of P. falciparum and the unresponsiveness of cutaneous and visceral leishmaniasis to antimonial therapy is a serious clinical problem that represents an important threat to the management of these diseases. There is a growing demand for the development of a rapid diagnostic test that will allow a complete direct identification of drug-resistant parasites in easily obtainable patient samples. The probes would call for a single reading of results by semi-skilled technical staff. The probes should be specific, sensitive and inexpensive. The quantities required for in vitro and field testing of each probe submitted is about 100 and 1000 reactions respectively.
   Phase I: Submission of potential probe(s) in the appropriate quantity and quality for in vitro testing against reference drug resistant and sensitive parent clones of the parasites.
   Phase II: Submission of additional quantities of specific probe(s) for field testing and evaluation.

A90-422   TITLE: Development of Novel Methodologies for Diagnosing and Evaluating Acute Schistosome Infections

CATEGORY: Basic Research

OBJECTIVE: The objective is to design a rapid, simple, specific methodology for detecting the early acute (Katayama-like) syndrome in individuals infected with Schistosoma mansoni.

DESCRIPTION: The acute phase of Schistosoma mansoni infection is gaining increased recognition as a debilitating disease syndrome. This Katayama-like syndrome is clinically non-specific and must be differentially diagnosed from other fever producing diseases. This is of particular concern relative to immunologically naive individuals who are returning from S. mansoni endemic areas, and who are presenting with these acute symptoms. Primary health care personnel need, therefore, a rapid, simple and specific diagnostic test which can be applied in the field to identify this early syndrome prior to the classical presentation of schistosome infection.
   Phase I: Submission of a measurable parameter that is unique to the early, acute schistosomiasis syndrome.
   Phase II: Submission of a simple deployable diagnostic test system for the measurement of the unique parameter determined in Phase I.

A90-423   TITLE: Multipurpose Centrifuge

CATEGORY: Advanced Development

OBJECTIVE: Develop a small, lightweight, multi-powered centrifuge for all combat casualty care relevant fluids.

DESCRIPTION: A centrifuge is needed to perform microhematocrit, urine sediment, fecal concentration, and plasma preparation procedures. Capability for use with QBC II hematology tubes is also desirable. Item must be small, lightweight, durable, and capable of being operated on batteries or AC (110/220V, 50-60 Hz).
   Phase I: Develop a working prototype centrifuge that will perform all required procedures.
   Phase II: Develop and test a production-level centrifuge that will perform all required procedures.

A90-424   TITLE: Cold Sterilizing Agent

CATEGORY: Exploratory Development

OBJECTIVE: Develop a stable powdered material which can be readily dissolved in water and used for the cold sterilization of dental instruments in the field.

DESCRIPTION: Currently available cold sterilizing materials are effective for certain applications but are all in solution form. The bulk and weight of these solutions present a logistical problem when considered for field use. A powdered material suitably packaged in waterproof packets and having an extended shelf life could be dissolved in water at the time of use. The resulting reduction in logistics requirements would be significant. The spectrum of activity of the material developed should be at least

equal to available cold sterilizing liquids which in general have been demonstrated adequate for the sterilization od dental instruments.

Phase I: Demonstrate feasibility of producing a powdered cold sterilizing agent.

Phase II: Development of a powdered cold sterilizing agent which can be solubilized in cold water and provide effective sterilization of dental instruments.

A90-425   TITLE: Hand-held Locator for Radiotransparent Foreign Bodies

CATEGORY: Exploratory Development

OBJECTIVE: Development of a light-weight, hand-held device to easily detect small radiotransparent, foreign bodies such as plastic fragments. The device will be used in surgery in the same manner as metal detectors are currently used to locate metallic foreign bodies in the human.

DESCRIPTION: In a battlefield situation, many types of fragments can become embedded in a soldier's body. If this fragment is nonmetallic, it poses two problems: (1) it may be difficult to obtain an accurate picture of it using conventional x-ray technology, and (2) during surgery, it is impossible to know for sure when the surgeon is approaching the foreign body. A small, hand-held metal detector can be used to locate metallic fragments, but there is no existing instrument that can locate nonmetallic fragments.

Phase I: The Phase I effort will develop a viable technology to be used for such a foreign body locator. The technology should lend itself to the development of hand-held prototypes that are light-weight and easy to use in field medical treatment facilities.

Phase II: These prototypes should be used in pre-clinical trials that show that applicability of the technology developed in Phase I. It should also be shown that foreign body locators could be efficiently manufactured.

A90-426   TITLE: Development of A Lensless Phoroptor

CATEGORY: Exploratory Development

OBJECTIVE: Develop a Lensless Phoroptor using laser speckle pattern motion to gauge refractive error.

DESCRIPTION: Currently, optometrists use a phoroptor containing a selection of lenses and a wall chart to measure visual acuity. laser Light which has been diffused by passing through a rotating cylinder will generate an interference pattern in space. If the eye is correctly focused, the pattern is stationary, the pattern will move at a rate and direction proportional to the amount of refractive error. A laser based phoroptor would not require the patient to make subjective judgements and could be more compact and easier to use than conventional equipment.

Phase I: Proof of the basic concept and breadboard phoroptor.

Phase II: Prototype equipment and evaluation with conventional phoroptors.

Strategic Defense Command

A90-427   TITLE: Electronics Materials for Anti-Satellite (ASAT) Application

CATEGORY: Basic Research

OBJECTIVE: The objective of this topic is to provide the necessary advances in electronic materials in order to improve the technology base for designing and developing lightweight, radiation hard, high performance electronic circuits for use in interceptors, active and passive sensors, and data/signal processing devices used in antisatellite applications.

DESCRIPTION: Novel ideas which improve radiation hardness, performance, power requirements, capability and/or weight of integrated circuits, detectors, sensors and other electronic or electro-optical components are sought in areas such as: quantum-well/superlattice structures which support "band gap engineering:, new organic and polymer materials with unique electronic/electro-optical properties, microstructure waveguides, solid state lasers, optical detectors, exploitation of single crystal diamond electronic properties, high frequency transistors, superconducting concepts.

Phase I: This phase should demonstrate the feasibility and scientific or technical merit of the proposed idea in order to reduce risk incurred with Phase II effort. The demonstration should consist of an experiment or simulation that clearly shows the potential of the concept, ie., the fabrication and characterization of a light emitting diode using new materials, novel processing or new concepts.

Phase II: This phase should address critical issues and result in a well defined product or process ready for the commercial development of a specific application. For example: activities would consist of determining performance as a function of

process variables and addressing the critical issues, which could include the integration of, perhaps a transistor with the other elements of a logic circuit for a given application.

Phase III: This phase should consist of applying the technology developed in the previous phase to a specific application, such as, fabricating components which would be incorporated in a neural network system for data/signal processing in an ASAT interceptor or other commercial application.

A90-428 **TITLE: Neural Network Software/Hardware for Directed and Kinetic Energy Anti-satellite (ASAT) Weapons System.**

CATEGORY: Basic Research

OBJECTIVE: To develop new and innovative neural network algorithms and architectures that will aid in developing a real-time, economical and reliable kinetic and directed energy antisatellite (ASAT) weapons system.

DESCRIPTION: Directed Energy (DE) and Kinetic Energy (KE) antisatellite weapons systems is a vital candidate system to our nations's defense. This weapons system has a need for knowledge base systems that are economical and provide accurate information in real-time. A neural network is a computational structure modeled on biological processes. Some of the key features of the neural network are its trainability and speed. Neural networks are a powerful tool that can increase the power of DE and KE antisatellite weapons knowledge base systems by helping the system learn faster and with less human programming. Approaches are sought to extend or improve present ASAT concepts, facilitate and reduce the cost of the concepts. Elements of the systems include, but are not limited to, weapons pointing, beam control, acquisition, tracking, sensor focal planes, signal and data processing, guidance and control algorithms, control of cryocoolers, array image processing and other ASAT system components.

Phase I: The first phase will conclude the feasibility of the concept through simulation and/or prototype and the applicability of the concept to ASAT weapons system. It will also show the merit of furthering the concept to a Phase II.

Phase II: The second phase will incorporate the principle developed in Phase I into a prototype or show proof of principle and feasibility for incorporation into the ASAT demonstration phase commercial applications will be considered.

Phase III: Results of Phase I and Phase II shall lead to a Phase III that will incorporate the developed principles into a specific ASAT test application and/or lead to specific commercial application.

A90-429 **TITLE: Sensor Signal and Data Processing for ASAT Application**

CATEGORY: Basic Research

OBJECTIVE: New and innovative approaches offering order-or-magnitude improvements to sensor signal and data processing performance, power, weight, size, and cost are desired.

DESCRIPTION: Modern sensors produce vast amounts of electronic signal information which must be processed quickly and accurately to perform surveillance and target tracking functions. Signal processing of the sensor data is first performed to identify object detections. Data processing is then performed to handle target tracking and other high level functions. Advances are needed both in hardware architecture and in algorithms to handle nuclear effects mitigation, structured background removal, object dependent processing, and multiple target tracking.

Phase I: A Phase I effort will identify one or more specific functional elements of the signal and data processing chain and seek a sizeable and realizable improvement to the components. This will include design and simulation of the improvement and proof of its technical merits.

Phase II: Phase II will develop the signal or data processing improvements from Phase I for a more detailed simulation/prototype demonstration of the advantages of the resulting hardware or algorithm.

Phase III: This Phase will involve the application of the processing innovation to real systems with possible industry or government cooperation. The product that emerges from Phase I or Phase II research shall be such that in Phase III either more research is required to finalize the development or it is ready to be introduced into the ASAT demonstration program and/or introduced into the private sector commercial market.

A90-430 **TITLE: Optical Computing and Optical Signal Processing Technology for ASAT Application**

CATEGORY: Basic Research

OBJECTIVE: Develop innovative optical materials, devices, components, architectures, and algorithms that will advance the technology. The innovative concept shall lead to a product that will increase performance for a specific function and/or reduce the power, weight, size, etc., of a component required by the ASAT system. This can be in any aspect of BM/C3, surveillance, acquisition, tracking or kill assessment, etc.

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DESCRIPTION: Orders of magnitude advancement in performance is needed in hybrid opto-electronic and in all computing and signal processing systems. This requires new and significantly enhanced nonlinear materials and photonic devices, acousto and electro-optic components, optically and electronically addressed SLMs and array processors, holographic techniques, reconfigurable interconnects, methods of massive fan-in/fan-out, and parallel algorithms and architectures. Applications include optical neural-network processors as well as general-purpose optical analog and digital computers and special-purpose optical co-processors and accelerators.

Phase I: The results of this effort will provide proof-of-concept feasibility by means of preliminary design, simulation, and laboratory experimentation. The product should be directly linked to some subsystem of the ASAT program and have potential commercial application.

Phase II: The results of this effort will include the detailed design, fabrication, demonstration, and testing and evaluation of a working, but not necessarily optimized, breadboard model. Consideration must be given to, and direct application shown, for improvement to some element of the ASAT program. Phase II must provide insights into the Phase II program which can be further government funded development (a procurement) or private sector commercialization.

Phase III: This effort will be the commercialization, as well as military application in missile interceptors and satellites, of high-density performance optical signal and data processing systems or subsystem.

A90-431   TITLE: Robotics and Artificial Intelligence (AI) for Anti-Satellite (ASAT) Application

CATEGORY: Basic Research

OBJECTIVE: The objective of this research is to explore innovative, novel decision aid concepts and robotic technology for ASAT applications including the BM/C3 functions.

DESCRIPTION: Innovative ideas for research designed to enhance an ASAT system decision making capability under severe environment are sought. Genetic algorithms and other self-adapting concepts which both reduce the time required to reach a decision and improve the decisions made are of particular interest. Also, innovative concepts for robotic techniques which will either aid in the maintenance of a deployed ASAT system or in the manufacture of components for an ASAT program are requested.

Phase I: During this phase, an innovative concept will be investigated and feasibility established via mathematics, computer simulation, prototyping or a combination of these. The concept must be shown to lead to a product that can go into a Phase II and have potential for a Phase III.

Phase II: A robotic technique or AI concept must be developed towards a clearly identified ASAT requirement. It must further be shown to have the potential for commercialization for either or both the government not the private sector. A robotic manufacturing demonstration, or a demonstrated expert decision system for the BM/C3 function are examples of a Phase II program.

Phase III: The results of Phase I and Phase II will be integrated within an ASAT system that will be used in an actual ASAT demonstration and validation experiment/or lead to a specific commercial application.

A90-432   TITLE: Computer Architecture, Algorithms, and Languages for Anti-Satellite (ASAT) Application

CATEGORY: Basic Research

OBJECTIVE: Demonstrate novel or innovative approaches for ground and space computer architecture, algorithms, and language to support target acquisition, tracking, classification/discrimination, kill assessment, and battle management/command, control, and communication (BM/C3).

DESCRIPTION: The ASAT program is pursuing the development of both a kinetic energy, and directed energy antisatellite concept. This ASAT program is to demonstrate current technology and will initiate product improvements as new technology becomes available. In support of this program, the following areas of interest are identified.

Computer architecture to improve processing speed, be parallel or distributed in layout, be more secure, with increased fault-tolerant capabilities, and have higher reliability are being sought. Innovative algorithms to increase data processing performance, include fault tolerance, and implement novel numerical techniques are requested. Languages to optimize operating systems for computer architectures, demonstrate improved man-machine interfaces, and allow for easy software updates and system testing are also of interest.

Phase I: To investigate and analyze the various approaches toward solving a particular problem area and recommend a single defined method. The method should be based on innovative concepts that will provide benefits to the ASAT program.

Phase II: To determine the Phase I method through a design, fabrication and/or encoding, and testing. During demonstration, the procedures to implement the method, schedules, resources requirements, and testing are documented and evaluated. Periodic testing provides a means of assuring that method can be successfully implemented.

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Phase III: This phase shall lead to components or systems that can be integrated into the ASAT prototype or demonstration program. Also, this phase should provide new products for civilian markets based on the technology transfer.

A90-433   TITLE: Laser Communications for ASAT Application

CATEGORY: Basic Research

OBJECTIVE: Research technologies which will enhance the feasibility of a laser communications network for elements of the ASAT program.

DESCRIPTION: A critical element of the ASAT program is a communications network. Highly desirable characteristics of a communications network are: high data rate, high resistance to jamming, rapid acquisition and tracking, switchable links, wide field of view, and secure links. This program is structured to explore the relevant innovative technologies which support laser communications links. These support technology areas include, but are not limited to: lasers, laser beam steering/control; modulation techniques/systems; receiver techniques/systems; and networking concepts.
        Phase I: New and innovative concepts are sought which will enhance the feasibility of laser communications links/networks. The Phase I effort should be structured to determine the feasibility of the proposed concept by the end of the Phase I performance period.
        Phase II: After the feasibility of the proposed concepts has been established in Phase I, the evolution of the concept will be continued during the Phase II effort. The concepts will be implemented in software/hardware to demonstrate the engineering feasibility of the concept and any critical engineering bottlenecks will be addressed and solved.
        Phase III: Following a successful Phase II effort, proposed concepts should have evolved to the point that full scale engineering development can begin to incorporate the concepts into a firm design as a component or major subsystem of a laser communications link/network.

A90-434   TITLE: Propulsion and Propellants for Anti-Satellite (ASAT)

CATEGORY: Basic Research

OBJECTIVE: Develop innovative propulsion materials, devices and components to provide substantial performance improvement and weight/volume reductions for kinetic energy weapons that utilize solid propellant rockets or hybrid liquid-solid energies.

DESCRIPTION: Order of magnitude advancement in performance is needed in advanced rocket propellant materials, motor cases and nozzles, and processing technology. This requires new and significantly enhanced energetic polymers and novel oxidizers; high strength to weight materials for rocket motors and nozzles; miniaturized devices and components; and improvement in automation science for chemical processes that contribute to safe mixing, handling and processing of highly toxic and energetic propellant ingredients.
        Phase I: The results of this effort will provide proof of concept feasibility be means of preliminary design, simulation, and laboratory experimentation.
        Phase II: The results of this effort will include the detailed design, fabrication, demonstration, and testing and evaluation of a working preliminary breadboard model.
        Phase III: The hardware should be developed to the stage where it can be demonstrated in a flight test.

A90-435   TITLE: Sensors, Detection, Tracking and Kill Assessment for Anti-Satellite (ASAT)

CATEGORY: Basic Research

OBJECTIVE: The objective of this program is to develop innovative sensors and related technologies for the ASAT program.

DESCRIPTION: The objective of this program is to develop innovative sensors and related technologies for the ASAT program. Sensors and their associated systems will function as the "eyes and ears" of an ASAT system providing target detection, target tracking and kill assessment. New and innovative approaches to these requirements using advanced concepts are encouraged across the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for acquiring and tracking targets against a variety of backgrounds are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed, with the intended goal of producing either a specific product or process. Examples of some of the areas to be addressed are: advanced focal plane arrays with on-focal-plane signal processing, range-doppler radar and radar, imaging (different wavelengths), improvement of detector efficiency and producibility, sensor fusion, gamma, x-ray and neutron detection, detection, agile lasers, radiation sources, and countermeasures to sensor are sought. Entirely new concepts as well as significant improvements are solicited.

Phase I: The results of this effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

Phase II: The results of this effort will include hardware or components developed to a state where they can be demonstrated in a flight experiment.

A90-436   TITLE: Structural Materials and Space Structures for Anti-Satellite (ASAT)

CATEGORY: Basic Research

OBJECTIVE: The development of advanced structural materials and advanced space structures for prime power systems, antennas, tracking and pointing systems, pressure vessels, solar collectors, lightweight large optics and other key ASAT subsystems.

DESCRIPTION: ASAT System requirements emphasize major improvements in material properties: stiffness, impact resistance, high temperature capability, etc. Other goals include advances in oxidation resistance and damage tolerance of composites, enhanced toughness of ceramic composites, and creation of fatigue-resistant metal composites with significant improvements in passive vibrational damping. Also sought are tribology innovative techniques, low density alloys, and methods to minimize fiber matrix reactions in composites exposed to high operating temperatures. Advances in passive and active control of structural dynamic responses to environmental and operational excitations are needed. These diverse needs will benefit from the development and incorporation of advanced material technology into all aspects of the ASAT program, including ground support, surveillance, and terminal kill.

Phase I: The results of this effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

Phase II: The results of this effort will include detailed design, fabrication, evaluation of a working but not necessarily optimized, breadboard or brassboard model.

Phase III: The results of this effort will include hardware or components developed to a state where they can be demonstrated in a flight experiment.

A90-437   TITLE: Directed Energy for Anti-Satellite (ASAT)

CATEGORY: Basic Research

OBJECTIVE: Develop innovative concepts for materials, components, design or architectures that will enhance the state of technologies for directed energy.

DESCRIPTION: Orders of magnitude advancement in energy on target, propagation beam control, target interaction and kill assessment are needed. Advancements in the areas of high-energy lasers, particle beams, microwaves or other directed energy devices are needed. Major enhancements in component technology such as: ion sources, beam control devices, accelerators, neutralizers, optics, amplifiers, lasing materials, and plasmas are requested.

Phase I: The results of this effort should prove feasibility through calculations, simulations, designs and preliminary experiments.

Phase II: The results of this effort will include the detailed design, fabrication, demonstration, and testing and evaluation of a working preliminary breadboard model.

Phase III: The hardware should be developed to the stage where it can be demonstrated in a flight test.

A90-438   TITLE: Surveillance and Early Detection for Anti-Satellite (ASAT)

CATEGORY: Basic Research

OBJECTIVE: Develop innovative surveillance and early detection sensors, devices, materials, components and architectures to advance the technology.

DESCRIPTION: Advances in surveillance and detection platforms, sensors, components, materials and architectures are needed. Significant evolutionary or revolutionary improvements in concepts or technology are required. Examples of areas to be explored are active and passive sensors, staring arrays with on-focal-plane signal processing, advanced radar concepts, surveillance platform concepts, advanced optics, detector materials, cryocoolers, platform stabilization and sensor pointing.

Phase I: The results of this effort will provide evidence of concept feasibility through preliminary design, calculations, modeling and preliminary experiments.

Phase II: The results of this effort will include detailed design, fabrication, demonstration and testing of a working, but not necessarily optimized breadboard model.

Phase III: Hardware or component should be developed to a state where it could be demonstrated in a flight experiment.

A90-439   TITLE: Kinetic Energy Concepts and Technology

CATEGORY: Basic Research

OBJECTIVE: Defense against satellites requires a highly efficient interceptor system. The goal of this research is to investigate and exploit concepts for advancing the state-of-the-art in kinetic energy technologies.

DESCRIPTION: This program will focus on developments in all technologies, systems, and subsystems which may be utilized in ground, air, and space-based satellite interceptors. Propulsion, airframe and materials, guidance, control, and warheads/lethality are the principal subtechnologies of prime interest.
    Phase I: The Phase I effort will provide proof of principle reasonability by means of preliminary design, simulations, and/or laboratory experimentation.
    Phase II: The Phase II effort will build upon the feasibility of the Phase I results to provide demonstration through design, fabrication and testing of a breadboard/brassboard model.
    Phase III: Hardware or component will be developed to the flight demonstration state.

A90-440   TITLE: Development of a Modern Standard Atmosphere Model for the Kwajalein Atoll Environs

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this topic is to develop a modern standard atmosphere model for the Kwajalein Atoll and to validate this model using available data.

DESCRIPTION: There are currently several different "Standard Atmosphere" models for the Kwajalein Atoll. These include the Kwajalein Standard Atmosphere and the Blood-Kwan Atmosphere among others. These models are fairly old and relatively crude in that they do not accurately characterize the atmosphere on any given day. These models are used to correct radar measurements real time and post mission for atmospheric effects in the troposphere.
    Phase I: Develop a prototype atmospheric model based upon a database of Meteorological Sounding System (MSS) sonde measurements taken in recent years and other modern measurement techniques including satellite observations and MMW space-averaged surface measurements available at Kwajalein. This effort will consider data accuracy and granularity and their effects on the potential for model development.
    Phase II: This effort will continue the model development and the validation of the model using available data. Also, this phase II will be to develop recommendations for additional measurements or instrumentation as appropriate.
    Phase III: A Phase III could be developed for applying, maintaining and upgrading the model.

A90-441   TITLE: Splash Detection and Surveillance Radar

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this topic is to investigate innovative, low costs radars for splash detection of reentry objects and safety surveillance.

DESCRIPTION: There is a current need for a highly reliable, low cost radar system to observe the splash down of reentry objects and to provide quick look or real time scoring. This radar system should also provide safety surveillance of aircraft and boats.
    Phase I: A low-cost, reliable radar concept should be defined and shown to the feasibility to meet the above objective.
    Phase II: The radar concept is to be further developed to show with simulations and/or prototype demonstrations that it will meet the KMR needs.
    Phase III: TBD.

A90-442   TITLE: AN/FPQ Radar Upgrade

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this topic is to develop innovative, low costs concepts to enhance the beacon tracking capability of the AN/FPQ.

DESCRIPTION: Currently the AN/FPQ Radar located in Kwajalein Island has a 50 MHz operational bandwidth. It is desired to upgrade this to a 500 MHz operational bandwidth. This capability is needed to enhance the ability of the FPQ radar in beacon tracking.
Phase I: The phase I is to define a low cost concept to meet the objective above and to show that the concept is feasible.
Phase II: Further develop the concept to fully demonstrate that the concept can meet the KMR requirement if installed in the FPQ radar.
Phase III: TBD.

A90-443   TITLE: Trajectory Estimation

CATEGORY: Exploratory Development

OBJECTIVE: Using data available from on or off-board sensors, determine maximum lift and drag forces acting on a reentry vehicle as a function of altitude. Use that information in the determination of the best estimate trajectory for the vehicle or at least to establish limits on the deviation from a ballistic trajectory which will be permitted in the fitting process.

DESCRIPTION: To obtain a very accurate trajectory for test vehicles flown to Kwajalein a Best Estimate Trajectory (BET) is formed by fitting a single trajectory through all the sensor data. Various schemes are used to determine and remove fixed biases, and weight the data by its measured quality and a prior knowledge of the various sensors' accuracies. In exoatmospheric flight, Keplerian motion is force, but in reentry where atmospheric forces affect the trajectory, few physical constraints are imposed on the motion. The results, particularly where the body is crossing gaps in the coverage between two sensors, are poor and show maneuvers which are not physically realizable. A more realistic assessment of the aerodynamic forces on the vehicle and the effects of those forces must be included in the BET process.
Phase I: Innovative concepts are being sought that have the potential to meet the objective. The Phase I effort should show the feasibility of the concept.
Phase II: Further development, testing, and validation of the concept to demonstrate the utility of the concept to mee· the KMR requirement.
Phase III: TBD.

A90-444   TITLE: Radio Frequency Hazard Monitoring - USAKA

CATEGORY: Exploratory Development

OBJECTIVE: To provide sensors and procedures which will allow efficient and rapid mapping of the RF power density at a large number of ground stations surrounding the USAKA sensors as a function of antenna pointing and transmitter power.

DESCRIPTION: USAKA has a number of high power radars which can generate unacceptable radiation levels on the ground if their pointing is not carefully controlled. RF surveys are conducted to determine the operational limits which must be imposed. Whenever antenna or transmitter changes are made, which is quite frequently, the surveys must be repeated. With the present equipment, the task is both time consuming and error prone. Ideas are sought for equipment and procedures which will allow more rapid and accurate surveys.
Phase I: Innovative concepts for meeting the above objective are to be shown feasible in this phase.
Phase II: Further development of this concept to fully demonstrate its capability to meet the KMR needs.
Phase III: Could be the installation on KMR.

A90-445   TITLE: Radio Frequency Hazard Monitoring - Kwajalein

CATEGORY: Exploratory Development

OBJECTIVE: Sensors are needed to provide a continuous record of RF field strength at various locations on Kwajalein. They should integrate over a time period consistent with that specified by (ANSI) C95.1-1982, and should be low enough in cost that many stations can be monitored.

DESCRIPTION: The safety of personnel on Kwajalein is guaranteed by imposing limits on where and when the many high powered radars can radiate. Particularly with electronically steered antennas a system which provided a continuous record of the actual fields created is imported to be certain that established limits are not inadvertently exceeded. Novel low cost approaches which could be widely deployed are sought.

Phase I: Innovative concepts for improving the safety of KMR personnel is to be defined. Sensor(s) capability and system concept is to be shown feasible.

Phase II: System concept, sensors, instrumentation and complete program is to be developed to fully demonstrate this idea and prove its utility if installed at KMR.

Phase III: Could lead to installation at KMR.

A90-446   TITLE: Development of Enhancement to the Data Collection Capabilities of Kwajalein Missile Range Systems

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this topic is the development of innovative concepts for enhancing the data collection capabilities of the Kwajelein based systems.

DESCRIPTION: Currently the Millimeter Wave Instrumentation Radar (MMWIR) is capable of collecting data on one target at a time. In order to collect data on other targets, it must be manually switched with a resulting loss of valuable and limited data collection time. This radar is located on Roi Namuir Island in the Kwajalein Atoll.

Phase I: Innovative concepts for improving this radar's data collection capability are being sought. During this phase, the concept should be defined well enough to show the feasibility of the innovation and how it enhances the data collection capability.

Phase II: The innovative concept should be further developed and demonstrated via an experiment and/or simulation that the concept is technically sound and can significantly enhance the data collection capability of the MMWIR.

Phase III: A Phase III could be the installation and testing of the concept on Roi Namuir.

A90-447   TITLE: Trajectory Fitting

CATEGORY: Exploratory Development

OBJECTIVE: To determine the source of and correct for error in present trajectory fitting and modeling processes.

DESCRIPTION: In its flight from the west coast to Kwajalein, a ballistic missile is observed by three sets of sensors, those in the launch and impact areas, and another set in Hawaii. When data from all the sensors is combined from a Best Estimate Trajectory (BET), a good fit to all the data cannot be obtained. The data from all the sensors within a set are consistent. A good fit can be obtained to any two sets of sensors, but not all three. It is believed that the mid-trajectory data is at fault, and two possible explanations are offered. The first is that the coordinates of the Hawaiian sensors are not accurately known. The second and more likely explanation is that the actual gravity anomalies affecting the trajectory are not adequately modelled by the earth model (WSG-84) currently in use.

Phase I: Innovative concepts are sought that have the potential to meet the objective. Phase I should show the feasibility of the proposed concept.

Phase II: Further development and testing of the Phase I concept.

Phase III: TBD.

A90-448   TITLE: Statistical Data for Orbital Debris

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative concept for modifying the Millimeter Wave Instrumentation Radar (MMWIR) to collect data on orbital debris.

DESCRIPTION: Man-made space debris or orbit debris remains in orbit during its lifetime and is not transient through the space around the earth. Information about the current debris environment is extremely limited by the inability to ffectively

track small objects. It is of interest to see innovative techniques, i.e. waveforms, adaptive processing, etc., that would allow the MMWIR to track small objects for cataloging and to develop a statistical characterization of the debris population in earth orbit.

Phase I: Investigate the ability of the MMWIR to be modified to allow the tracking of small orbital debris. Also, define the size of the smallest object possible for tracking.

Phase II: Develop the modification idea and show through simulation, analysis, or other sound engineering principles that the concept will meet the objective.

Phase III: TBD.

A90-449   TITLE: Signal Processing Enhancement for GBR-X Radar

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative signal processing methods and signal processors to enhance the planned GBR-X radar capability.

DESCRIPTION: The planned GBR-X radar will have a capability dictated by current state-of-the-art hardware and software. Therefore, innovative algorithms and/or hardware concepts are sought that have the potential to significantly improve the planned capability. This could include optical signal processors and related components.

Phase I: Develop and show the feasibility of an innovative signal processing concept.

Phase II: Demonstrate through simulation, experimentation, and/or prototyping that the concept has the capability to significantly enhance the performance of the GBR-X.

Phase III: TBD.

A90-450   TITLE: Development of a Display Gallery for USAKA Mission Data

CATEGORY: Exploratory Development

OBJECTIVE: To develop a design for a display gallery on Kwajalein Island to display extensive data from the GBR-X and KREMS in a cost effective way.

DESCRIPTION: Current mechanical radars at USAKA generally handle only one object at a time and hence display needs have been limited. The phased array GBR-X, in contrast, can handle a few dozen objects simultaneously and thus a desire exists for an extensive display capability. It happens that the rapid progress which is occurring in the small computer area offers the potential for providing very numerous displays at a moderate cost. These displays as a minimum should display a range do; ler image and a summary of body motion information on each of the twelve objects.

Phase I: Develop a top level display design in sufficient depth to show feasibility and cost effectiveness.

Phase II: Develop a preliminary design for a display gallery defining interfaces and practical issues in sufficient depth to define a low-risk program for building the display gallery.

Phase III: TBD.

Army Research Institute for Behavioral and Social Sciences

A90-451   TITLE: Skill Retention as a Function of Acquisition Training Variables

CATEGORY: Exploratory Development

OBJECTIVE: To develop task performance prediction models as a function of: task type and skill acquisition training strategies (e.g., performing a task to criterion once vs. X number of times, spacing practice over hours, days or weeks; providing frequent performance feedback vs. withholding feedback until performance exceeds a specified error bound).

DESCRIPTION: Currently, the U.S. Army schools typically provide training on skills to the level of novice capability rather than mastery, because of the time and expense that would be required to conduct more extensive training. The basic training strategy is to explain and show soldiers how to perform a task, and then have them perform it once or a few times before moving on to the next tasks; it is expected that soldiers will acquire skills at the appropriate level of expertise by on-the-job-training. However, when soldiers arrive at units, they often fail to remember what they were taught at school, and supervisors have only very limited opportunities to provide refresher and mastery level training. Training theory and supporting data are needed to enable development of training strategies that optimize school and unit resources to produce soldiers who can perform their job tasks well, especially under the stress of combat.

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Phase I: Select an appropriate taxonomy for soldier tasks, and modify as required. Prepare skill performance prediction models reflecting alternative training strategies. Prepare operational definitions for all criteria and predictor variables.

Phase II: Design and conduct a small-size validation effort for selected tasks categorized by the taxonomy.

A90-452   TITLE: Modeling the Master Tutor

CATEGORY: Exploratory Development

OBJECTIVE: There is a need to understand the processes, cues, algorithms, techniques, and knowledge about the learner, that Master Tutors possess and use so that these functions can be emulated in Computer-Based Instruction (CBI). Although CBI has been developed and used in a variety of training settings during the last two decades, its promise as an "individualized" tutor has not been achieved. One reason is that most of the research to date has used the instructional interaction, the student, or the content as the focus.

DESCRIPTION: Over the past decades, there have been developed models of the learning process, models of the student's knowledge state, models of subject matter structure, instructional strategy decision models, etc. These models have arisen from a variety of theoretical positions. A similar model or set of models is needed to reflect the tutorial expertise that should be part of CBI.

Phase I: Phase I of this research requires the development of a comprehensive taxonomy of the knowledges, behaviors, cognitive and non-cognitive skills, methods, algorithms, etc. that are critical to a Master Tutor's effectiveness. Two or three domains (which have widely differing skills characteristics) shall be chosen for empirical data to be collected from protocols of Master Tutors at work. A revised model shall then be developed.

Phase II: Phase II of this SBIR program requires the validation of the taxonomic model developed in Phase I. Initially, the goal of this Phase will be to see if the characteristics of a Master Tutor derived from the model, can be transferred to other instructors. If so, the model's structure, rules, and other features shall be incorporated in a CBI program in one of the domains from which it was derived, and in one that was not used for protocols. A comparison shall be made of the effectiveness of the CBI programs with and without the tutorial model; and another comparison with direct instruction by the Master Tutor(s).

A90-453   TITLE: Measurement of Performance of Army Tactical Units

CATEGORY: Basic Research and Exploratory Development

OBJECTIVE: To establish methodology for improved measurement of performance of U.S. Army tactical units.

DESCRIPTION: The U.S. Army needs to be able to adequately measure the performance of its tactical units in order to estimate the Army's combat capability, diagnose training requirements, and determine the resources required to support training. Measurement is also essential for evaluating new weapons systems, tactics, and organizational designs. Measurement needs to address all levels from squad through battalion task force.

The U.S. Army traditionally has used mission/task analyses to establish the attributes of performance which should be trained and evaluated. While useful, by its very nature the analytic approach leads to emphasis of "fractional" parts of performance and often fails to capture the dynamic, emergent, interactive and tightly coupled aspects of unit performance. Additional approaches are needed which emphasize synthesis and more integrated, molar performance indices, the nature of such molar indices may be suggested by the high level constructs contained in, for example, "combat fundamentals", "tenets of the airland battle", etc., described in military history and doctrine. Alternatively or complementarily, it may be useful to apply mathematical and modeling techniques to the problem of identifying and measuring molar aspects of unit performance.

Phase I: The objectives of this phase are to: (1) formulate hypotheses, theories, or models which identify molar aspects or attributes of unit "performance" which should be observed and measurement operations and analytic techniques which permit their testing and validation; (2) establish measurement operations and analytical techniques which permit their testing and validation; (3) conduct analyses to demonstrate the feasibility and potential utility of the methodology. Data from the National Training Center (NTC) and Joint Readiness Training Center (JRTC) can be made available for these analyses. The final report will fully describe the process and result of this phase.

Phase II: The objectives of this phase are to validate and refine the methodology and measures. This will involve extensive application of the methodology to real data and comparison of the results with results from other methods of describing and assessing unit performance. The final report will fully describe the process and results from both phases.

A90-454   TITLE: Dimensions for Military Occupational Specialty

CATEGORY: Advanced Development

OBJECTIVE: To provide dimensions and associated methods which can be used to analyze the commonalities versus differences between job requirements (e.g., equipments, tasks, organizational location). The use of resulting data will provide information useful for evaluating alternative MOS and Career Management Field (CMF) restructuring possibilities in terms of manpower, personnel, and training impacts.

DESCRIPTION: Work is ongoing at ARI to develop decision tools to support the selection, design, and redesign of MOSs and CMFs to meet force modernization requirements. Attention is initially being focused on Signal and Military Intelligence (MI) MOSs and CMFs but it is intended that the tools will be expanded to deal with other combat, combat support, and combat service support branches. It is expected that, for each tool developed, the overall approach and procedure will be common to all branches. It is also expected, however, that some dimensions or considerations within some tools will be branch specific. For example, all the dimensions used to describe signal equipment so as to analyze commonalities and differences from the soldier's task performance standpoint are not expected to be necessary or sufficient to describe tank weapons.

Phase I: Initial work completed on the question of how to usefully describe Signal branch equipments and MI aptitude requirements will be critically reviewed and analyzed to understand the approaches and make recommendations. Subsequent Phase I and Phase II work in either of these two areas or in other areas (e.g., tasks, organization) will be coordinated with this work and is to be complementary. Drawing upon the Signal branch, MI branch, or other approaches, the major branch-specific characteristics of other combat, combat support, and combat service support branches are to be reviewed. Apparent differences in the selected area of analytic dimension development are to be identified and two or more branches selected for the Phase II effort. The selection is to support the goal of adding dimensions and procedures to the selected commonality analysis tool so that it is applicable to all the combat, combat support, and combat service support branches.

Phase II: The necessary and sufficient additional dimensions and procedures for analysis of selected area commonalities in the branches selected in Phase I are to be identified and developed. They are to complement and be integratable with other ongoing or completed work on the development of MOS and CMF restructuring analysis tools.

A90-455   TITLE: Officer Force Structure Planning Model

CATEGORY: Exploratory Development

OBJECTIVE: An Officer Force Structure Planning Model is required to provide users with manpower cost and force structure implications of changes in personnel policies, particularly those involving changes in current or future compensation. The model could be used to directly demonstrate the effect of manpower policies, such as changes in compensation or retirement programs, on the officer force structure.

DESCRIPTION: A series of recent efforts have been directed towards providing better retention and cost information that can be used to evaluate the cost and force structure implications of manpower policies on the enlisted force. Similar models would provide tools to evaluate manpower policies directed towards officers.

Phase I: Phase I of this research requires development of a theoretical framework of U.S. Army officer retention behavior, specifying an empirical model that can be estimated, consistent with the theoretical model, and estimating the retention models using ACOL-2 specifications (the Annualized Cost-of-Leaving models correcting for sample selection over time) for major occupational specialties. ARI's Officer Panel Research Data Base would be available for estimating these models.

Phase II: Phase II of this SBIR program requires integrating the retention-behavior parameter estimates from Phase I, and officer manpower cost data from AMCOS, into a prototype Officer Force Structure Planning Model.

A90-456   TITLE: Measurement of Combat Performance

CATEGORY: Exploratory Development

OBJECTIVE: To identify tools for the measurement of combat performance.

DESCRIPTION: Typically, selection tests for the military are evaluated in terms of their empirical validity for predicting peacetime performance. Yet, the ultimate success of the military is evaluated in terms of wartime, not peacetime performance. Reliable and valid measures of individual performance in a combat environment are needed as criteria for predictor measures developed for selection and classification of enlisted soldiers.

Phase I: Phase I would involve a review of the relevant literature to determine if this literature provides a foundation for the development of preliminary combat performance measures for Army enlisted soldiers. The product of Phase I would be a plan for the development of these measures in Phase II.

Phase II: In Phase II the contractor, using the Phase I results supplemented by interviews with combat veterans as needed, would develop a preliminary set of measures of combat performance. These measures would be reviewed by subject matter experts and revised as necessary.

Armament Research Development and Engineering Center

A90-457   TITLE: Advanced Seekers for Smart Munitions

CATEGORY: Exploratory Development

OBJECTIVE: This work can be transitioned to a Phase III application when the contractor successfully demonstrates a new type of seeker system that has superior performance to ones currently used in STAFF or Search and Destroy Armor (SADARM).

DESCRIPTION: The U.S. Army Research, Development, and Engineering Center (ARDEC) has committed itself to developing an evolutionary family of both "shoot to kill" as well as "hit to kill" smart projectile munitions throughout the foreseeable future. Past examples of this thrust are seen in the Copperhead projectile, currently in production, as well as search and destroy armor (SADARM) now in full scale development. These munitions will rely on increasingly autonomous seekers capable of finding a variety of ground targets immersed in terrain situations. In some cases, the red and millimeter wave technologies form the conventional baseline approaches. Seekers are still in an evolutionary state and are limited in their performance against complex backgrounds, weather adversities and countermeasures. It will be necessary to enhance the performance in future evolutions of this technology. Topics of special interest to ARDEC are hybrid semi-active (SAL)/infrared (IR) seekers, focal plane array/imaging IR seekers, strapdown seekers, advanced millimeter wave integrated circuit seekers, and dual-mode IR/MMW seekers.

Phase I: Perform a paper study and design on the proposed seeker system for an autonomous munition. This paper should include analytical the proof of concepts on the enhanced performance over a present day seeker. Also, a proposed hardware design that can operate under high G conditions including proposed signal processing methods to detect targets in real world clutter.

Phase II: Design and build the seeker from Phase I preliminary design to perform under captive flight test conditions and operate coherently with signal processing algorithms designed in accordance with the Phase I proposal. Through CFT the contractor shall prove the systems enhanced functionality and performance, with real world data (clutter) in an environment specified by ARDEC, over the present day seeker system discussed in the Phase I final report.

A90-458   TITLE: Advanced Adaptive Weapon Control Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate low cost high performance digital servo control technology for precision fire-on-the-move applications including armor, air defense and aircraft system applications.

DESCRIPTION: Recently progress has been made in demonstrating major accuracy improvements for both aircraft and combat vehicle weapon systems using advanced digital control design techniques and Linear Quadratic Gaussian Loop Transfer Recovery (LQG LTR) design approaches. Further improvements in gun accuracy are anticipated through the development of improved robust nonlinear and adaptive control laws and control laws that exploit recent advances in H infinity and ℓ_1 sensitivity minimization techniques. High speed, low cost micro computer technology now permits these techniques to be implemented in high bandwidth digital servo loops required for precision gun stabilization. This project will address the broad spectrum of issues associated with the development of design tools and methodology, modeling, simulation and real time hardware/software implementation.

Phase I: Develop methodology for design and implementation of high performance robust adaptive and nonlinear control laws for precision weapon stabilization and tracking. Formulate specific control laws for nominal two input, multi output nonlinear plant with friction, backlash, resonant modes, high impulse periodic disturbances nonlinear compliance and sensor noise. Determine performance and robustness characteristic with respect to structural and unstructured plant perturbations and provide analysis of hardware/software implementation requirements.

Phase II: Develop a fully integrated design, test and prototyping environment for advanced nonlinear and adaptive multivariable control systems. Provide a real time programmable digital control module with online data analysis capability and I/O capability necessary for laboratory test bed evaluation. Optimize module hardware/software and algorithm design based on test data and provide complete documentation of algorithms and hardware/software architecture.

A90-459   TITLE: Electro-Magnetic Interference (EMI)/Electro Magnetic Pulse (EMP)/High Power Microwave (HPM) Protection for Packaged Ammunition

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the feasibility of providing electromagnetic interference/electromagnetic pulse/high power microwave (EMI/EMP/HPM) protection for ammunition through packaging using cost-effective techniques.

DESCRIPTION: Recently the military has been concerned with the sensitivity of ammunition to EMI/EMP environments. With the incorporation of electronic fuzes and guidance system, and other sensitive hardware into todays ammunition, susceptibility is a major concern. In addition, there have been significant advances in the field of HPM. It is felt that HPM generators may create detonation and burnout problems for ammunition.

   Currently, it is not known to what level protection is provided to ammunition by the use of metal, plastic and fiber ammunition containers. It is theorized that metal containers should attenuate most of the EMP/EMI/HPM field, but there is concern about transmission through the gasket (closure) area. Due to the inherent characteristics of plastic and fiber materials used, it is possible that current containers will provide little or no protection against these fields. It must be determined to what level protection is being provided by the use of these materials in all the generic container designs currently being manufactured. Once the attenuation levels are determined, cost effective ways of shielding can be analyzed, including container gasket shields, gasket additives and material additives/processing.

   Phase I: To determine the level of protection of ammunition from EMI/EMP/HPM afforded by plastic, fiber or metal packaging containers. Provide theoretical analysis of the attenuation provided by generic container designs and the possible improvements that could be achieved through design modifications, processing techniques/materials and external or internal shields. Provide economic analysis of levels of protection that could be achieved vs. cost.

   Phase II: Test existing generic designs against EMI/EMP/HPM to determine actual levels of field attenuation through sides and gasket area. Analyze correlation of experimental results with theory. Develop improved shielding methods, incorporate into existing container designs and retest. Analyze correlation of experimental results with theory. Re-evaluate shielding levels obtained vs. cost.

A90-460   TITLE: Fire Control Battle Management and Decision Support System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate advanced expert system decision aids for armor and/or artillery applications.

DESCRIPTION: The feasibility of developing high performance expert system decision aids for armor and artillery system applications has been demonstrated recently based on laboratory prototype tests. Further technology development is required, however, to address specific algorithmic issues associated with real time planning/replanning, sensor/information fusion, terrain analysis, as well as issues of knowledge engineering, man/machine interface, rapid prototyping and simulation environments for evaluating decision aids. Expert system decision aids which address one or more of the following requirements are of specific interest: (a) Identification Friend or Foe (IFF), (b) Fire Control (acquisition/tracking), (c) tactical planning/order preparation, (d) tactical situation assessment, (e) status/reports, (f) self defense of weapon platform, (g) sustainment, (h) command and control, (i) fire direction, (j) communications, (k) reconnaissance, selection and occupation of position and (l) embedded training.

   Phase I: Develop methodology for design and implementation of distributed expert system decision aids for artillery and/or armor applications. Formulate and define conceptual designs for specific expert system modules including hardware implementation and software prototyping environment. Develop detailed functional specifications.

   Phase II: Develop a full-up laboratory prototype decision support system with appropriate displays, simulation driven, development environment and run-time environment. Optimize hardware/software, algorithm and interface design based on laboratory test results and provide complete documentation of hardware/software, analysis and test results.

A90-461   TITLE: Advanced Signal Processing Methods for Smart Munitions Seekers

CATEGORY: Exploratory Development

OBJECTIVE: This work can be transitioned to a phase III application, when the contractor successfully demonstrates a new target detection, clutter rejection algorithm which provides superior probability of detection and lower false alarm rates than currently available for applications in Search and Destroy Armor (SADARM) or STAFF.

DESCRIPTION: This U.S. Army Research, Development, and Engineering Center (ARDEC) has committed itself to developing an evolutionary family of both "shoot to kill" as well as "hit to kill" smart projectile munitions throughout the foreseeable future. Past examples of this thrust are seen in the Copperhead projectile, currently in production, as well as search and destroy armor (SADARM) now in full scale development. Seekers and sensors in future munitions will be faced with increasingly complex decision making situations. The front-end hardware, infrared (IR), and millimeter wave (MMW) will provide a rapid, continual stream of serial and parallel analogue signals representing the world sensed by the seeker. Entire space-time maps at state-of-the-art resolution levels may be available in the IR bands, the millimeter wave bands, the acoustic bands, the active radar bands, and possibly any combination of all of these. The pattern-recognition challenge is a substantial one. The goal of the seeker will be to detect, identify, classify, locate, and track at any instant the desired target(s) in an unpredictable, complex, frequently frustrated set of world data. Current and future hardware advances in large scale integrated circuits (LSIC), very high speed integrated circuits (VHSIC), optical computers and future parallel processing architectures must be tied together with current and future advances in software, advanced algorithms, and artificial intelligence disciplines to form a cohesive and believable structure of feasibility for future munitions. In brief, the challenge of advanced signal processing is to desire the "brain principles (software)" to service the "eyeball-ear principles (hardware)".

Phase I: Perform a paper study on the proposed new concept of a target detection algorithm with emphasis on high background clutter conditions and potentially suppressed target signatures. This should include proof of enhanced functionally and performance over current designs. All calculations and procedures should be included with detailed definitions.

Phase II: Software shall be written using Phase I final report guide lines. Proof of concept will be proven through testing of the algorithm. Final testing of the algorithm shall be performed by ARDEC with simulated and real world data in both high clutter and clutter free environments. The software shall have the capability of being tested by an independent group. It is preferred that the software can be eventually mapped onto very high speed integrated circuits which will go into a munition.

A90-462   TITLE: Optical Designs for Enhancing Laser Eye Protection

CATEGORY: Exploratory Development

OBJECTIVE: Designs for direct view optical sights which will enhance the operation of non-linear optical switches, sacrificial mirrors and other optical limiters placed in focal planes.

DESCRIPTION: To protect operators of a direct view optical sight from laser eye damage, optical limiters based on non-linear processes, plasma formation and sacrificial mirrors must be placed in a focal plane of the system. Present systems are designed with the primary goal of presenting an adequate image to the eye. The purpose of this program is to add the requirement of improving the concentration of energy in the focal plane of the system in order to trigger limiters at a lower threshold of input energy.

Phase I: An army optical sight will be analyzed to determine its efficiency in concentrating coherent radiation at its focal planes. A 10x, ±4 deg. field-of-view system will be designed with the goal of matching its performance and increasing the concentration of flux in the focal plane. The final report will contain the optical design and analysis.

Phase II: A device based on this Phase I design will be fabricated. Imaging performance will be measured and compared to that of a conventional system. Measurement of the point spread function in the system's focal plane will be measured.

A90-463   TITLE: Small Caliber Primer Automated Inspection System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a reliable, safe and cost effective method to perform 100% automated inspection of small caliber primers.

DESCRIPTION: Approximately 2.1 million 5.56mm primers and 7.62mm primers are produced and 100% visually inspected every day at Lake City Army Ammunition Plant (LCAAP). The current primer inspection operation is very labor intensive and the inspectors are constantly exposed to a hazardous energetic material. Four to five operators are engaged in manually inspecting the primers in each charging wing. Each inspector manually dumps a box containing 1,416 primers into a tray and then orients the primers in one direction. After the primers have been oriented, the inspector looks for visual defects through a magnifying glass and culls the defective primers. Then the primer tray is covered and turned over, enabling the operator to inspect the other side of the primers. One box of primers is inspected in about three minutes. It is impossible to maintain a consistent standard of inspection since factors like operator skill, fatigue, emotional mood, and judgement influence the efficiency of this operation. Thus, there exists a lot of variation from inspector to inspector. Since there is no accurate way to determine that the proper amount of primer mix has been placed in the primer cup, it is up to each individual inspector to determine what

constitutes a normal or light charge. The same is true with other defects: it is up to each inspector's judgement. Testing conducted to-date shows that the efficiency of each operator decreases throughout the day due to fatigue and the conditioning effect of repetitive tasks. While the cost of an individual primer ranges from a fraction of a penny to a few cents per primer (depending on type), a malfunctioning primer either causes the complete round of ammunition to be useless or, in the case of a hangfire, it could prove to be potentially dangerous to the user.

Thus, quality and safety are two factors of major concern in the manufacturing of primers. The current primer inspection operation at LCAAP is inadequate. The quantity of primers, the number of inspections per primer, and the size of the primers make the inspection operation difficult and inefficient. The inspection of small caliber ammunition is very subjective and highly dependent on the operators skills and experience. Some of the major and critical defects, i.e., too much shellac, light primer charge, are difficult if not impossible to consistently detect. As a result, defective primers may pass through the inspection operation undetected, later causing weapon and cartridge malfunctions.

Phase I: Determine the feasibility of utilizing existing or modified automated machine inspection systems to perform the required small caliber primer visual inspections, and to determine if the proper amount of primer mix is present in the primer. The capability of a machine inspection system to detect each of the primer defects should be evaluated. Hardware and software specifications should include camera type and resolution, microprocessor, speed, memory requirements, interfaces, support equipment, software type and modification. Also, recommendations on the type of primer handling system should be provided.

Phase II: Fabricate a primer inspection machine prototype and material handling system to automatically inspect primers at a rate in excess of 1500 primers per minute. Provide the necessary parameters (lighting condition, camera position, primers orientation, etc.) to optimize inspection operation. Evaluate the prototype capability in terms of reliability and repeatability, and make the necessary hardware and software modification to optimize the inspection equipment performance.

A90-464   TITLE: Rapid Solidification Processing of Tungsten Alloys

CATEGORY: Exploratory Development

OBJECTIVE: Develop the means of producing pilot plant quantities of rapidly solidified processed high tungsten content (>96%W) alloys for ballistic evaluation as kinetic energy penetrator rods.

DESCRIPTION: Attempts to rapidly solidify process tungsten alloys by jet ribbon methods have been partially successful with tungsten contents approaching 80 weight percent. Higher tungsten content alloys require higher temperature casts and these become more corrosive/erosive to the containment crucible and nozzle delivery system. Most standard ceramic materials for the containment crucible and nozzle have not been effective. Standard atomization approaches would also need to consider proper containment of the melt and controlled delivery. Rotating electrode schemes although doing away with the container, would need to dedicate a great deal of effort in fabricating the precursor electrodes. Modified "skull casting" techniques adapted to a regulated dispensing of a molten stream may offer a potential solution. Innovative approaches are therefore sought to reliably exploit rapid solidification technology for high content (>96 weight percent) tungsten alloys.

Phase I: Develop a methodology for rapid solidification processing of high tungsten alloys. Utilizing various alloy compositions evaluate process characteristics and establish key parameter values to enable the reproducible production of research quantities of processed tungsten alloy powders. Explore consolidation schemes to produce full density bulk stock for mechanical property evaluation.

Phase II: Scale-up processing equipment to provide batch yields of 1-5 kgm. Systematically examine the effects of various process parameters on the mechanical properties and microstructure of the final consolidated products and thereby define suitable processing for full scale application.

A90-465   TITLE: Intelligent Sensor Based Robotic Control Systems Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a generic multi-adaptive robotic control module and development environment for mobile manipulator systems for ammunition handling, resupply and logistics applications.

DESCRIPTION: Significant progress has been made recently in developing advanced sensor based servo control systems for high performance robotic manipulators. Specifically, a high speed 386 based multi-processor robotic control module and software development environment was developed which permits a broad range of adaptive and compliant motion control strategies to be implemented for arbitrary manipulator configurations. Extensions of this technology are required, however, to deal with fundamental problems of mobility and base motion effects, flexibility task level control, multisensor integration, dual arm coordination associated with fusing ammunition in a moving resupply vehicle, and depalletizing and transferring ammunition to and from a resupply vehicle, and depalletizing and transferring ammunition to and from a resupply vehicle and loading

ammunition in a moving platform environment. Technical issues of interest include robust and adaptive controls, compliant motion control, visual servo control, voice natural language interface for control, dual arm control strategies, world modeling design environment, real time, knowledge based task level control and control from moving base including path planning, navigation and obstacle detection/avoidance.

Phase I: Develop methodology and algorithmic approaches to intelligent sensor based robotic control systems for applications to material handling and loading. Perform preliminary modeling and simulation studies to determine performance/robustness characteristics of the control laws and algorithms, real time processing requirements and sensors requirements. Provide analysis for evaluating control laws and provide control processor design and system hardware specifications.

Phase II: Develop controller hardware/software and development environment for interface with laboratory test bed manipulator systems. Develop test scenarios and scaled down mock-ups to demonstrate controller performance capabilities. Provide fully integrated prototype module with documentation source code and development environment and evaluate in laboratory tests.

A90-466   TITLE: Pre-Dyed Bullet Jackets

CATEGORY: Basic Research

OBJECTIVE: Develop a method of drying bullet cups before they are drawn into bullet jackets.

DESCRIPTION: At present, after the cartridges are finished being assembled they undergo a tip identification process which applies a paint to the cartridge tip to identify its function (Blank, Tracer, etc). Basically, depending on the cartridge size the process for tip identification is slightly different, 5.56 mm are spray painted, 7.62mm are dipped in paint. Either way tip identification is a separate process that adds time and therefore cost to the cartridges. To cut cost and process time it would be advantageous to develop a method of dying the bullet before it is manufactured. More importantly by eliminating the lacquering process the emissions of hydrocarbons would be greatly reduced. This would be an important environmental asset.

Phase I: Develop methodology for dying the copper cups used to make bullet jackets. Formulate processing characteristics and examine the metallurgic properties and the consequences of dying the cups. Provide cost analysis for implementing the use of pre-colored cups.

Phase II: Build a prototype of the process needed to dye the cups. Fabricate a sufficient amount of cups to be drawn and processed into bullets. Load cases with these bullets. Provide a performance analysis to determine if the dye process had any effect on bullet performance. Also, determine the effect if any on the firing weapon.

A90-467   TITLE: Effects of Long-Term Storage on Electronic Devices

CATEGORY: Exploratory Development

OBJECTIVE: To identify failure mechanisms, investigate and determine cost effective packaging techniques while determining new technologies and design methods for protecting electronic devices during long-term storage. Draw on these results to generate a guide which will be used by ARDEC as a design manual for reducing or eliminating the adverse dormant storage effects on Smart Munitions.

DESCRIPTION: Electronic components and devices used in one shot ammunition such as Smart Munitions experience a completely different life-cycle than most electronic components. They will be stored for long periods, sometimes up to 20 years, in an inactive state and then must operate reliably over a short, active lifetime. Most data on the reliability of electronic components provide information on the failure rate per 1000 hours of active life. Little inactive life data is available that directly applies to Smart Munitions, namely SADARM Munitions, and presently, long term storage effects are not predictable. Since large numbers of integrated circuits (ICs) and other related devices are being and will be used in a number of Smart Munitions programs, ARDEC is investigating the overall problem of assuring component reliability and the associated ordnance problems which emerge as a result of storing electronic devices for periods of up to 20 years. ARDEC is concerned with: ensuring component operation; long-term storage effects of electrical specifications; predicting possible failure modes, or their trends; and with identifying and analyzing mechanisms, packaging techniques and failure modes so that they can be corrected or designed out of the system.

Phase I: Identify the factors that will cause deterioration of electronic devices on long-term storage, as well as the principal failure mechanism(s) and what analysis and testing is required to proveout these failure mechanisms in Smart Munitions applications.

Phase II: Utilize the data and results, developed and surfaced in phase I, to investigate and determine the appropriate packaging methods, new technologies, materials, and designs, for protecting, decreasing, and eliminating the adverse effects of

dormant storage. Address critical electronics located in Infra Red (IR), Millimeter Wave (MMW) sensors, and associated Smart Munition electronics. Drawing on the data generated in Phase I and II prepare a design manual which will be used as a guide for protecting electronic componentry and circuits from the adverse effects of long-term storage.

A90-468   TITLE: Standardized Digital X-Ray Viewer

CATEGORY: Advanced Development

OBJECTIVE: Develop and implement an image viewer for very high resolution archived images.

DESCRIPTION: The Army has developed several systems for automated x-ray inspection of armament devices and material using digitized x-ray images. The images and the analysis results are archived in digital format on 8mm Sony video tape. Current images are stored as 8-bit grey levels, 512 x 512 pixels; future systems will use higher resolution.
    This solicitation is for the development of a inexpensive system which can recover, duplicate, enhance, further process, and display the images. Such a system needs to read the archived data, strip out the image data from the rest, and display the image data and the analysis data on user demand. The images will need visual enhancement before being displayed.
    The system should be developed so that one may increase its capability incrementally with various options. One of those options would be to duplicate the image analysis capability of the original inspection system. Such an options could be used to perform off-line algorithm development or merely to further process an archived image.
    The system should be developed around pc or workstation computers of the nature which are readily available to DOD. The system should include all hardware, interfaces and software. Wherever possible hardware and software components should be readily available consumer items.
    The Army will be expanding the requirement for automated x-ray inspection systems to the manufacturers of munitions items. The Phase III marketplace for the system developed under this topic will be the load plants and manufacturers of these munitions items.
    Phase I: Develop a prototype system with at least minimal capabilities to recover, duplicate and display the archived data. This prototype system should costs less than $10,000 if it were to be purchased as an off-the-shelf item. The software of the prototype shall be a Phase I deliverable. Write a full detailed scope of work (SOW) for the total system which will be developed and completed in Phase II.
    Phase II: Develop and deliver a total system. The system, discounting the option of image analysis, should cost less than $20,000 if it were to be purchased in duplicate or as on off-the-shelf item. The image analysis option should simulate that of the automated x-ray inspection systems currently used by the Army.

A90-469   TITLE: Electronic Safe and Arm for High Velocity/Acceleration Projectiles

CATEGORY: Advanced Development

OBJECTIVE: Develop an electronic safe and arm of high velocity/acceleration projectiles.

DESCRIPTION: The development of the slapper detonator and associated electronic components have made the design of in-line all-electronic safe and arm mechanisms feasible. Electronic safe and arm mechanisms (ESA) are now being designed for missile applications. ESA's offer advantages for high velocity projectiles as well. One such advantage is the improved reliability gained from a safe and arm mechanism with no moving parts.
    However, the high-G launch environment and restrictive size and power requirements add to difficulty of designing an ESA for high-velocity projectiles.
    Phase I: Design a module containing a slapper detonator and high-voltage converter and trigger circuits which can be utilized in a fuzing system for a high-acceleration projectile.
    The module shall be no more than 1.25 inch in diameter. A length of 2 inches or shorter is desired. The module shall be operable after being subjected to launch accelerations of 50,000 G's minimum. The module shall be charged and capable of providing an output within 15 milliseconds after application of power. The explosive output of the module shall be in the direction of the applied acceleration. The module shall operate when powered by voltages from 24 to 32 volts and shall draw a current not to exceed 1 A. RMS.
    Phase II: Fabricate 10 prototype modules for high-G airgun and lab tests. Refine the design where necessary.

A90-470   TITLE: Verification and Validation of Expert Systems

CATEGORY: Basic Research

OBJECTIVE: To develop a comprehensive methodology to perform verification and validation of expert systems, and to incorporate these items into an automated tool(s) to facilitate its use.

DESCRIPTION: Software engineering methodologies exist which can be used in the verification and validation (V&V) of weapon system software. Governing standards include DOD-STD-2167A, Defense System Software Development, DOD-STD-2168, Defense System Software Quality Program, and MIL-STD-1815A, Ada Programming Language. However, the V&V of expert systems (knowledge based systems) poses some unique problems not typically faced with non-AI software engineering. Some of the factors which may contribute to these problems are:
- A modularized, top-down structured architecture may not be possible in all expert systems.
- Defining testable requirements for expert systems is difficult.
- Expert systems tend to be more problem-oriented than process-oriented.
Phase I: Phase I should investigate, but not be limited to, the following items:
1) Specifically, what are the characteristics and/or methodologies of expert systems that differentiate them from that of software development efforts which use classical software engineering? Examples of items to investigate include:
- Defining/determining requirements for expert systems/knowledge based systems.
- Testing an expert system and its knowledge base(s).
- Documenting an expert system and its knowledge base(s).
- Expert system architectures.
- Rapid prototype development of expert systems.
2) How do these differences impact how V&V is performed? How can these differences be dealt with and resolved?
3) Who is performing research and/or similar work in this field?
4) Are there automated tools which can be used to accomplish these tasks?
Using the information gathered, determine a methodology and/or a series of checks and balances which can be used to perform V&V on expert systems. All software life cycle phases should be addressed. The results should be documented in a handbook and/or technical report.

Phase I should include two visits to Picatinny Arsenal, NJ, one for an initial kickoff meeting, and one for a final presentation. Bimonthly progress reports and a final technical report should be provided, documenting all work performed, problems encountered, results achieved, and conclusions reached. All documentation and software developed shall be delivered on both 1) paper listing and 2) magnetic media (format to be approved by the government).

Phase II: Using the Phase I results as a baseline, Phase II should develop a comprehensive methodology and/or checklists for performing V&V for expert systems. These items should then be incorporated into an automated tool(s) to facilitate its use. The contractor shall also provide comprehensive software documentation for the developed tool. Detailed requirements for the tool will be determined upon successful completion of Phase I.

A90-471   TITLE: High Speed Method of Primer Drying

CATEGORY: Exploratory Development

OBJECTIVE. Develop an explosion proof method of drying small caliber primers, 5.56mm, 7.62mm, Cal .50, and 20mm, in less than five minutes to meet production requirements for pellet weight control.

DESCRIPTION: The whole primer consists of a cup, disc, anvil and pellet. For example, the 5.56mm primer no. 41 found on drawing no. 10534279 consists of a pellet made of Lead Styphnate, Tetracene, Barium Nitrate, Antimony Sulfide, Aluminum powder, Petin, and Gum according to Primer Composition FA-956, drawing no. 10522386. On the current production line the pellets are made in trays that are divided first in half and then each half in fifths. One pellet from each of the ten sections is weighed. The primer pellets are weighed in a wet condition assuming 10% moisture. The assumption has caused the scrap out of primer pellets that were within specification for dry weights, but were scrapped due to varying amounts of moisture in the pellets at the time of wet weighing. The current procedure requires three hours for drying and one hour for cooling before weighing the dry primer.
Phase I: Investigate methods and techniques for drying primer pellets. (i.e., convection and/or vacuum drying) with explosion proof apparatus. The new process should take less than five minutes to be practical for production requirements.
Phase II: Construct and/or procure a model of the method selected. Work test this model, set up test to prove out the accuracy, repeatability, and output efficiency of the equipment.

A90-472   TITLE: Powdered Metal Preforms for Barrel Liners

CATEGORY: Exploratory Development

OBJECTIVE: Develop a process for inserting and finishing a powdered metal preform barrel liner which permits the use of superior material in the rifled barrel section without a unacceptable cost impact.

DESCRIPTION: Recent improvements in hot isostatic pressing techniques have allowed an Austrian company to supply full length liners made from Nimonic 105 to a Swiss gun manufacturer. The linear preform is then pressed as a full length liner component in a twin gun product. This technique allows a thin layer of a State-of-the-Art material to be utilized as a component part of a layered barrel. In turn, the limits presently placed on the use of high performance propellants and barrel life can be drastically extended with this technique without the attended cost impact of a homogeneous State-of-the-Art material barrel.

Phase I: Develop methodology for the process of producing full length preforms and insertion into a conventional material barrel hollowed to allow the press fit of the powered metal preform. The costs of powdered materials, isostatic pressed necessary finishing equipment finished product output, intangible performance benefits and spare barrel inventory reductions would be evaluated against present cost profiles of a high performance machine gun barrel such as the M60.

Phase II: Given that both the benefit of performance advantage and spare barrel inventory reductions, construct a pilot operation to produce rifled preformed Nimonic 105 liners and further processing for insertion in used and rebored M60 barrels. Develop producibility and efficiency factors on pilot operation.

A90-473 TITLE: Integrated Target Recognition and Tracking

CATEGORY: Exploratory Development

OBJECTIVE: Develop fire control systems for air and ground targets that use high resolution imagery for enhanced trajectory prediction.

DESCRIPTION: The subject of this topic involves tracking the present position of a maneuvering aircraft or ground vehicle as well as predicting its future position. Tracking filters for both fixed and rotary wing aircraft have already been developed that use attitude angles (yaw, pitch, roll) in addition to the usual radar measurements. Computer simulation of tracker performance when tracking violently maneuvering aircraft indicates that a dramatic improvement is obtained by using optically-derived attitude information. It is desired to develop a similar filter for ground vehicles and to test it against real targets, as well as to improve the performance of the aircraft trackers and test them against real targets.

The development of an automatic target recognizer that will accurately determine target type and orientation is very important to this topic and may include techniques for global and partial shape recognition of three-dimensional objects by using two-dimensional exterior contour information, or recognition of three-dimensional objects by using three-dimensional surface information, or use of time-varying imagery to segment shape. Neural networks may prove useful here in hybrid combination with classical shape description methods. The development of very fast Kalman-filter calculation techniques is also important to this topic because of the requirement to work in real time and indicates the necessity of using parallel computations and making appropriate simplifying assumptions in the filter structures.

Phase I: Develop methodology for integrated target recognition and tracking of violently maneuvering aircraft and ground vehicles, including target identification and identification and orientation determination algorithms, tracking and prediction algorithms, and choice of a target locator and imaging sensor hardware suite.

Phase II: Develop a demonstration of the integrated target recognition and tracking algorithms working in near real-time against real targets.

A90-474 TITLE: Computer Model for Indirect Fire Control System Simulation

CATEGORY: Advanced Development

OBJECTIVE: The objective is to develop a PC based computer model for simulation of indirect fire control system.

DESCRIPTION: A need exists to develop a PC based simulation model that will model the indirect fire (i.e., target not in direct line of sight from the weapon) fire control process to enable the simulator user to characterize a fire control system (either existing or conceptual) and to determine its performance against specified targets. The simulation shoul' model, to a useful level of detail, the entire indirect fire process from location of a target, transmission of that information to a tactical fire control center, assignment of a fire mission to weapon(s), computation of the technical fire control data, laying of the weapon, flyout of the bullet to the target and, finally, location of the impact with respect to the target. Using such a model, an investigator could determine the sensitivity of the weapon system performance to a large number of system parameters and external variables associated with fire control. Examples of such investigations are: investigation of the potential benefit of

monitoring individual round muzzle velocity and the use of that data to correct the firing data for subsequent rounds; investigation of the potential benefit of monitoring individual round muzzle velocity and the use of that data to correct the firing data for subsequent rounds; investigation of the potential benefit of observation of the fired projectile's flight path and application of correction to subsequent projectile based on the difference between the observed trajectory and expected trajectory; examination of the sensitivity of the indirect fire ballistic solution to meteorological data errors; examination of the sensitivity of the system performance to weapon location and alignment errors. The simulation should be capable of operation on an IBM compatible PC and should operate in a manner consistent with acceptable user friendly formats. It should be modular in construction so that portions can be modified and updated as necessary. It should contain adequate storage capacity so that a large number of real and conceptual fire control systems can be defined and stored for later use.

Phase I: Investigate the indirect fire, fire control problem to determine its basic structure. Define the basic structure of the simulation to model that process. Develop some software to demonstrate sufficient features of the model to enable a Phase II decision to be made. Provide a cost and schedule to complete the model development and validate it by comparison of the model to real system test results.

Phase II: Complete the simulation development and support its installation on PCs at ARDEC. Provide support during demonstration and training of ARDEC users. Use ARDEC supplied real system test data to validate the model by demonstrating that the results obtained from it agree, to an appropriate level, with those from the test.

A90-475   TITLE: Sight Integration of an Automatic Muzzle Reference Sensor

CATEGORY: Advanced Development

OBJECTIVE: Develop an Automatic Muzzle Reference Sensor fully integrated in the fire control system, i.e. into the ballistic computer and a primary sight, to be employed in the Abrams Main Battle Tank (M1MA1) or future armored vehicles.

DESCRIPTION: Recent developments in the Automatic Muzzle Reference Sensor (AMRS) arena have made it possible to provide muzzle orientation data from an instant before trigger-pull occurs, until long after the bullet exists the gun barrel. The resultant of this source of data is the ability to aim a weapon with a much higher degree of accuracy, thus substantially increasing the hit probability of a gunner's system. Currently, main gun muzzle position is measured by conducting a measurement of the muzzle position using a manual Muzzle Reference Sensor (MRS) and comparing them to a reference position achieved by going through a boresight procedure. Various attempts at improving the existing manual reference sensor have achieved a tremendous increase in the ability of the MRS to survive the harsh muzzle environment, but have done little towards meeting main gun accuracy requirements.

In view of the above, the time is appropriate to fully integrate an AMRS device into the Fire Control System, providing the ballistic computer with an automatic update of muzzle orientation before each bullet is fired (and possibly gather information as the bullet is traveling along the tube) and to further integrate the primary sight into the AMRS loop by referencing the end of the muzzle to the main sight.

Phase I: Develop concepts and projected performance for integration of an Automatic Muzzle Reference Sensor into the Fire Control System (sight and Ballistic Computer) on an M1A1 vehicle. This will provide the ability of the ballistic computer of interpret the muzzle orientation data from the AMRS, and to process the data through the ballistic solution so that the proper reticle offset by projected on the primary sight.

Phase II: Implement the system developed in Phase I and integrate it into the Gunner's Primary Sight (GPS) on an M1A1 vehicle. It is expected that relative motion will take place between the GPS and the AMRS transceiver unit, therefore, a scheme has to be developed to compensate for such motion (or eliminate the use of transceiver at the trunnions) and have that information processed through the ballistic computer.

Army Research Office

A90-476   TITLE: Magnetic Field Processing for Improved Material Properties

CATEGORY: Basic Research

OBJECTIVE: To develop the principles influencing the properties of materials processed under magnetic fields.

DESCRIPTION: Pulsed magnetic fields can influence the metallurgical properties of a wide range of ferro and dia-magnetic metals and alloys. This influence has been shown to be directly related to the interaction of the magnetic field energy with the defect structure of the crystal lattice. With careful study and development, these effects may be used to influence important mechanical properties such as extending fatigue life by the modification of surface and subsurface dislocation structure and stress relief by promoting dislocation and vacancy movement. The focus of the study will be to further our understanding of the

fundamentals of metallurgical changes affecting fatigue properties and stress relief as well as the influence of variation of magnetic field properties.

Phase I: Develop the principles underlying the use of pulse magnetic fields in the processing of improved materials.

Phase II: Assess and demonstrate the potential of this technology to improve the fatigue life of military and commercial components.

A90-477   TITLE: Tribology of Refractory Ceramics

CATEGORY: Basic Research

OBJECTIVE: Perform research to provide new technology and processes for reduced wear and corrosion of refractory ceramics.

DESCRIPTION: Prototype ceramic engines must operate for extended periods of time reliably. Research is needed for the discovery and design of new classes of solid state lubricants that are resistant to deterioration.

Phase I: The goal of Phase I is to identify potential candidate classes of materials and processes for introducing lubricants; rationalize choices through crystal chemical design criteria, and carry out preliminary experiments establishing their usefulness.

Phase II: The goal of Phase II is to validate the high temperature ceramics lubrication potential of materials identified in Phase I.

A90-478   TITLE: Time-Accurate Wall Shear Stress Transducers

CATEGORY: Basic Research

OBJECTIVE: To develop new unsteady wall shear-stress transducers with enhanced spatial and temporal resolution.

DESCRIPTION: The measurement of wall shear stress is of vital importance for many problems in aerodynamics and fluid mechanics, especially for separated and/or turbulent flows. Unfortunately, the quantitative measurement of this quantity is a very difficult task. Techniques such as Preston and Stanton tubes, hot-film gauges, floating elements and thermal tufts have all been used to measure wall shear stress. Additionally, a new generation of laser techniques (interferometric, LDA, dual cylindrical wave laser doppler, etc.) have recently been developed. Unfortunately, each of these methods have limited spatial and temporal resolution which limits their use for the measurement of wall shear stress in many unsteady separated flows. The focus of the current solicitation is the development of new non-intrusive direct techniques capable of accurate wall shear-stress measurements with adequate temporal and spatial resolution. Small but rugged transducers, resistant to normal handling and installation forces but with high frequency response, are of particular interest.

Phase I: The basic research activity of Phase I should include the examination of the various concepts and design options for the proposed scientific instrumentation.

Phase II: The Phase II goal is the development and validation of the prototype(s) of the best-concept design alternatives, leading to Phase II commercialization of the transducer.

A90-479   TITLE: Refractory Materials Coating Processes

CATEGORY: Basic Research

OBJECTIVE: Perform research to provide new technology for refractory materials coatings/surface modification processes.

DESCRIPTION: Refractory materials coatings/surface modification technology is required for many U.S. Army applications requiring erosion, corrosion and wear resistance at high temperature. Such protective coatings/surface modifications must be adherent and have reduced stress levels over wide temperature ranges.

Phase I: The goal of Phase I is to identify potential candidate processes; to rationalize choices based upon environmental, performance, thermodynamic, kinetic, and economic considerations; to carry out preliminary experiments establishing the correctness of the approach chosen, and to establish preliminary design criteria for scaleup.

Phase II: The goal of Phase II is to design and operate a pilot scale implementation of the approach chosen in Phase I.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of the Chief of Naval Research. The Navy SBIR program manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR program manager's attention and should be addressed to:

    Office of the Chief of Naval Research
    ATTN: Mr. Vincent D. Schaper
              Navy SBIR Program Manager
    800 North Quincy Street, BCT #1, Room 934
    Arlington, VA 22217-5000
    (202) 696-4286

The Navy has identified 78 technical topics in addition to the 310 identified in the DOD Program Solicitation 90.1 to which small R&D businesses may respond. A brief description of each topic is included along with the address of each originating office. This information is contained on the ensuing pages.

SBIR proposals shall not be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

The Navy's mission is to maintain the freedom of the open seas. To that end the Navy employs and maintains air, land and ocean going vehicles and personnel necessary to accomplish this mission. The topics on the following pages provide a portion of problems encountered by the Navy in order to fulfill its mission and are an increase over previous years.

Selection of proposals for funding is based upon technical merit and the evaluation criteria contained in this solicitation document. Because funding is limited the Navy reserves the right to limit the amount of topics funded under any topic and only those topics considered to be of superior quality will be funded.

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

Administrative
Topic Nos. N90-311 through N90-318

Mail/Handcarry Address:

Office of Naval Research   Dr. D. Polk
Attn: ONR Code 1131M, Room 607   (202) 696-0283
     SBIR Program, Topic No. N90-_____
800 N. Quincy Street, BCT #1
Arlington, VA 22217-5000

Topic Nos. N90-319 through N90-322

Mail/Handcarry Address:

Office of Naval Technology   Mr. D. Harry
Attn: ONT Code 20T, Room 502   (202) 696-4453
     SBIR Program, Topic No. N90-_____
800 N. Quincy Street, BCT #1
Arlington, VA 22217-5000

Topic Nos. N90-323 through N90-327

Mail Address:

Commanding Officer   Ms. Maxine Channon
MCRDAC, SBIR Program, Topic No. 90-_____   (703) 640-2761
Amphibious Warfare Technology Directorate
Quantico, VA 22134-5080

Handcarry Address:

MCRDAC, SBIR Program, Topic No. N90-_____
Amphibious Warfare Technology Directorate
Lucas Hall, Room 9
Marine Corps Base
Quantico, VA 22134-5080

Topic Nos. N90-328 through N90-360

    Mail Address:

    Headquarters, Naval Air Systems Command   Mr. J. Johnson
    Department of the Navy   (202) 692-7393
    Attn: Code AIR 9303D, SBIR Program, Topic No. N90-___
    Washington, DC 20361-9301

    Handcarry Address:

    Headquarters, Naval Air Systems Command
    Department of the Navy
    Jefferson Plaza #1, Room 472
    1411 Jefferson Davis Highway
    Attn: Code AIR-9303D, SBIR Program, Topic No. N90-___
    Arlington, VA 22202

Topic No. N90-361

    Mail Address:

    Commander   Mr. W. Degentesh
    Naval Sea Systems Command   (202) 692-9871
    Department of the Navy
    Attn: Code CET-4, SBIR Program, Topic No. N90____
    Washington, DC 20362-5101

    Handcarry Address:

    Commander
    Naval Sea Systems Command
    Crystal Plaza #5, Room 924
    2211 Jefferson Davis Highway
    Attn: CET-4, SBIR Program, Topic No. N90-___
    Arlington, VA 22202

Topic Nos. N90-362 through N90-365

    Mail Address:

    Commander   Mr. D. Wilson
    Naval Surface Warfare Center   (202) 394-1279
    White Oak Laboratory
    Attn: Code S-02, SBIr Program, Topic No. N90-___
    Silver Spring, MD 20903-5000

    Handcarry Address:

    Commander
    Naval Surface Warfare Center
    White Oak Laboratory
    Bldg. #1, Reception Room
    Attn: Code S-02, SBIR Program, Topic No. N90-___
    Silver Spring, MD 20910

Topic Nos. N90-366 through N90-373

   Mail Address:

   Commander   Ms. L. Herrington
   Naval Weapons Center   (619) 939-2712
   Attn: Code 2503, SBIR Program, Topic No. N90-___
   China Lake, CA 93555-6001

   Handcarry Address:

   Commanding Officer
   Naval Weapons Center
   515 Blandy Avenue, Annex A1
   Attn: Code 2503, SBIR Program, Topic No. N90-___
   China Lake, CA 93555-6001

Topic No. N90-374

   Mail Address:

   Commander   Mr. E. W. Patno
   Pacific Missile Test Center   (805) 989-7916
   Attn: Code 3121, SBIR Program, Topic No. N90-___
   Point Mugu, CA 93042-5000

   Handcarry Address:

   Commander
   Pacific Missile Test Center
   Bldg. 50 Room 1100
   Attn: Code 3121, SBIR Program, Topic No. N90-___
   Point Mugu, CA 93042-5000

Topic No. N90-375

   Mail/Handcarry Address:

   Commander   Mr. R. Lynchard
   Naval Training Systems Center   (407) 380-4620
   Attn: Code 641, SBIR Program, Topic No. N90-___
   Central Florida Research Park
   12350 Research Parkway
   Orlando, FL 32826

Topic Nos. N90-376 through N90-381

Mail Address:

Commanding Officer   Mr. R. Dobrowolski
Naval Air Propulsion Center   (609) 896-5754
Attn: Code PE31, SBIR Program, Topic No. N90-___
P.O. Box 7176
Trenton, NJ 08628-0176

Handcarry Address:

Commanding Officer
Naval Air Propulsion Center
Attn: Code PE31, SBIR Program Topic No. N90-___
1440 Parkway Avenue
Trenton, NJ 08628-0176

Topic Nos. N90-382 through N90-384

Mail Address:

Commander   Dr. R. November
Naval Ocean Systems Center   (619) 553-2103
Attn: Code 0141, SBIR Program, Topic No. N90-___
San Diego, CA 92152-5000

Handcarry Address:

Commander
Naval Ocean Systems Center
Attn: Code 2172, Bldg. 88, SBIR Program, No. 90-___
San Diego, CA 92152-5000

Topic Nos. N90-385 through N90-388

Mail Address:

Commander   Mr. D. Watters
Naval Air Test Center   (301) 863-1144
Attn: Code CT222, SBIR Program, Topic No. N90-___
Patuxent, River, MD 20670

Handcarry Address:

Commander
Naval Air Test Center
Bldg. #304
Attn: Code CT222, SBIR Program Topic No. N90-___
Patuxent River, MD 20670

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DEPARTMENT OF THE NAVY
FY 1990 SMALL BUSINESS INNOVATION RESEARCH TOPICS

OFFICE OF NAVAL RESEARCH

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N90-312 Group IV Semiconductor Atomic Layer Epitaxial Technology

N90-313 4-Dimensional Environmental Sensors

N90-314 Arctic Environmental Sensors

N90-315 Oxidation Resistant Coating for Carbon-Carbon Composites

N90-316 Very High Framing Rate Digital Camera

N90-317 Neural Network Applications for Nondestructive Inspection of Aircraft

N90-318 Embedded Transputer-Based System Design

OFFICE OF NAVAL TECHNOLOGY

N90-319 Non-toxic Antifouling Paint

N90-320 Shipborne/Airborne Target Extraction Sensor

N90-321 Equipment Support Structural Concepts

N90-322 Methodology for Decision Making Processes

U.S. MARINE CORPS

N90-323 Fire Resistant Assault Suit

N90-324 Noise-Eliminating Assault Radio Headset

N90-325 Distributed Explosive Demolition Kit

N90-326 Lightweight Automatic Agent Detector

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NAVAL AIR SYSTEMS COMMAND

N90-328 Electromagnetic Field Sensor for Application to Electromagnetic Compatibility Concerns

N90-329 Non-contact Dimensional Gauging

N90-330 Flight Simulator Visual System Recording/Evaluation Device

N90-331 Miniaturized Solid State Computer Screen Display System with Interactive Voice Control

N90-332 Determination of Edge Distance Requirements for Fastener Holes in Advanced Composite Panels

N90-333 Laser Soldering Inspection System

N90-334 Thickness Gauging of Complex Coatings on Turbine Components

N90-335 Conformal UHF (SATCOM) Antenna for Tactical Aircraft

N90-336 Aircraft Wheel Usage Indicator System

N90-337 Aircraft Brake Usage Indicator System

N90-338 Non-asbestos Replacement Materials for Navy Aircraft

N90-339 Low-cost Electronic Warfare Response Monitor

N90-340 Advanced Armament Stubwings for Marine Attack Helicopters

N90-341 Electro-Optical (E/O Infrared (IR) and Multi-mode Missile Countermeasures

N90-342 Integration of Advanced Technology Components for Airborne Electronic Warfare (EW) Applications

N90-343 Application of Operations Research Systems Analysis Techniques to Quantitatively Assess Emerging Electronic Warfare Related Technologies

N90-344 Short Term Stability Attainment Device with Minimal Oscillatory Signature

N90-345 Advanced Fire Extinguishant Development

N90-346 Utility of Enhanced Maneuverability for Tactical Aircraft

N90-347 Enzymatic Deterioration and Removal of Aircraft Coatings

N90-348 Fiber Optic Research for Military Uses

N90-349 Prevention of Electromagnetic Pulse Effects on Fiber Optic Connectors

N90-350 Built-In Test Circuitry for Fiber Optic Systems

N90-351 Artificial Intelligence (AI) and Neural Network Technologies for Mission Planning and Execution Applications

N90-352 Aircraft Integrated Navigation Processing Technology

N90-353 Shallow Water Anti-submarine Warfare (ASW) Sensor

N90-354 Long Range Anti-submarine Warfare (ASW) Sensor

N90-355 High Brightness Cockpit Displays Using Field Emit Array (FEA) Or Similar Integrated "Cold" Electron Source Technologies

N90-356 Application of Dynamic Lift for Enhanced Maneuverability

N90-357 Assessment on Composite Impact Damage Technology Development

N90-358 Surface Residual Stress Analysis of Metals and Alloys

N90-359 Thermal Stability Enhancing Additive for JP-5 Fuel

N90-360 Cruise Missile Survivability Enhancement Through Deceptive Electronic Countermeasures (ECM)

NAVAL SEA SYSTEMS COMMAND

N90-361   Incentives for Manufacturing Technology

NAVAL SURFACE WARFARE CENTER

N90-362   Nonlinear Optical Processing Using Photopolymer Film Technology

N90-363   Polarization Insensitive Radomes for High Speed Missiles

N90-364   Signal Processing For Anti-Radiation Missile Receivers

N90-365   High Efficiency Ada Compiler

NAVAL WEAPONS CENTER

N90-366   Amplifying Ferromagnetic Echoing Device

N90-367   Light Emitting Diode/Laser Array for Optical Correlator

N90-368   Development of Mobile Surface-clutter Mapper

N90-369   Electromagnetic Wave Analysis of Radomes Shielding Spiral Antennas

N90-370   Parachute Load Transfer Reduction

N90-371   Dual Function Optical Scanner

N90-372   Neural Network Applications to Flight Control

N90-373   Miniaturized Metallic Glass Accelerometer

PACIFIC MISSILE TEST CENTER

N90-374   Electronic Optical Vector Scoring System

NAVAL TRAINING SYSTEMS CENTER

N90-375   Texture Modeling Techniques for Simulation of Infrared Sensor Displays for Mission Practice in Night/Low Visibility Conditions

NAVAL AIR PROPULSION CENTER

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N90-377   Unmanned Air Vehicle (UAV) Propeller Erosion Protection

N90-378   Innovative Small Engine Concepts

N90-379   Lightweight Remotely Piloted Vehicle Engine Alternator/Starter

N90-380   Fuel/Icing Inhibitor Recovery Using Crossflow Membrane Separator

N90-381   High Energy Density, Long Life Secondary Battery Research and Development

NAVAL OCEAN SYSTEMS CENTER

N90-382   Air Traffic Control by 3D Volumetric Display System

N90-383 Integrated Planar Magnetics For High Density Power Supplies

N90-384 LSI (Large System Integrated) Neural Networks For Associative Memory Arrays

NAVAL AIR TEST CENTER

N90-385 Helicopter Simulator Rotor Disk and Blade Element Comparison

N90-386 Deep Water Pinger Locator System

N90-387 Dynamic Laser Threat Illumination System

N90-388 Wide-band Imaging Spectroradiometer System

OFFICE OF NAVAL RESEARCH

N90-311 TITLE: Innovative Sensors Based on STM and Related Technology

CATEGORY: Research

OBJECTIVE: To develop a new class of microfabricatable sensors.

DESCRIPTION: The scanning tunneling microscope (STM) has demonstrated exquisite sensitivity of the tunneling phenomena to small changes (0.01nm) in the separation of two surfaces placed nanometers apart. This sensitivity, and its availability at all fluid/solid interfaces, presents an opportunity to devise new classes of sensors. Preliminary analyses suggest that the tunneling tip may offer distinct signal/noise advantages for microfabricated sensor technologies. Materials which alter their dimension or their position with change in environment, i.e. pressure, temperature, acceleration, gravity, magnetic field, electric field, etc.--can be used with tunneling to detect small changes in the environment. Other influences on the tunneling process due to electric, magnetic or electromagnetic fields may also be exploited for sensing. The goal of this program is to develop new sensor concepts based on microfabricatable tunneling geometries and to investigate their implementation using state-of-the-art technologies.

During the Phase I program research will address (1) new concepts in transducing changes in environment or incident energy into electronic signals based on tunneling; (2) analysis of the potential signal to noise (S/N) of the transducers; (3) signal processing approaches to enhance the S/N; and (4) system design to realize a sensor package.

During the Phase II program, the Phase I concepts will be further developed to the point of feasibility demonstration for real-time, microfabricatable sensors.

N90-312 TITLE: Group IV Semiconductor Atomic Layer Epitaxial Technology

CATEGORY: Research

OBJECTIVE: To develop self-limiting epitaxial growth.

DESCRIPTION: Chemically self-limiting atomic layer epitaxial (ALE) growth techniques have been known for nearly a decade in the II-VI semiconductors and for several years in the III-V semiconductors. Only recently has the ALE of silicon and compatible insulators been demonstrated. The choices of reactant gases, chamber pressures and temperatures, flow rates, and alternative processes have not yet been optimized, and the full extent to which the growth of semiconductors, insulators, and their interfaces are amenable to ALE is unknown. The technology is expected, inter alia, to significantly impact the production yield of submicron integrated circuit technology.

During the Phase I program, research will address (1) the optimization of reactant gas choices and growth conditions for a selected group IV semiconductor (e.g., silicon, silicon carbide, diamond). Proposals for various alternative chemically self-limiting reaction processes are encouraged.

During the Phase II effort, the Phase I research will be extended (1) to the point of demonstrating feasibility for increased production yields, (2) to demonstrate the efficacy for forming new device structures employing vertical wall ALE for lateral nanometer lithography, and (3) to develop prototype equipment for commercial implementation of self-limiting atomic layer epitaxial growth of group IV semiconductors.

N90-313 TITLE: 4-Dimensional Environmental Sensors

CATEGORY: Research

OBJECTIVE: To develop innovative sensors for environmental parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain marine atmospheric, oceanographic (acoustical, optical, physical, biological, chemical, and geophysical) parameters in 3D space and time. The emphasis is on: (1) novel approaches and concepts to obtain traditional variables, but in 4D; (2) new methods for monitoring previously unmeasured

parameters (e.g. fluxes, bubbles, biological distributions, absorption, trace elements, etc.); and/or (3) data transmission concepts (includes data storage and navigation data) to support 4D measurements. Instruments can be towed/tethered sensors, elements in arrays, or suites of instruments on ROVs (remotely operated vehicles) to cite a few examples. Low cost and/or expendable sensors and components are particularly valuable.

In the Phase I proposal, design concepts for measurement of particular or many of the parameters listed above must be described along with the explanation of the new/novel physics, chemistry, etc. involved. Phase I research should provide concept definition with feasibility demonstration of those components that are state-of-the-art or unique untested designs.

Phase II would develop hardware and demonstrate feasibility in the laboratory. Field testing would depend on the opportunity of adding the tests to an ongoing ONR field effort.

N90-314   TITLE: Arctic Environmental Sensors

CATEGORY: Research

OBJECTIVE: To develop new sensors and sensing concepts for Arctic environmental forcing parameters and ice motion and deformation.

DESCRIPTION: New remote and in situ sensing concepts and devices are solicited to coherently measure Arctic ice canopy distortion, air/ice and ice/water boundary layer deformation, and ice stress buildup. For example, a small remote aircraft with LIDAR and video camera or an aerostat with a search radar may satisfy imaging of ice and air/ice boundary measurement. An underwater ROV (remotely operated vehicle) with appropriate sensors may solve the ice/ocean boundary quantification needs.

The Arctic ice canopy is a collage of floes that are put into motion by winds, water currents, Coriolis force, and ocean dynamic height acting upon them. Under these influences, the ice drag coefficients and strength of the ice canopy determine its stress level and the motion it undergoes until restricted by continental margins. When the ice floes are gridlocked, stresses build up until the strength of the ice sheet is exceeded, resulting in rafting, ridge/keel building, lead formation, and ice canopy distortion. Imaging the ice distortion over time and space while monitoring air/ice and ice/ocean boundary layer deformation and stress build up in the ice canopy would provide researchers with the input/output parameters needed to develop and verify ice dynamics models.

The Phase I proposal should provide a concept definition of the instrumentation and identify the components that are critical to developing a feasible design. The proposal will lay out a plan that shows how the design and the critical components will be investigated to arrive at a final concept design.

In Phase II, development of an instrument as well as feasibility testing in the laboratory would be required. Field testing would be conducted if an ONR sponsored effort coincides with the project completion.

N90-315   TITLE: Oxidation Resistant Coating for Carbon-Carbon Composites

CATEGORY: Research

OBJECTIVE: To develop new coatings for carbon-carbon composites (CCC) capable of providing oxidation resistance at temperatures in the range 1600-2000 deg.C.

DESCRIPTION: Current protective coating technology for CCC is based on silicon carbide or silicon nitride with boron compounds added to provide a crack filling molten glass. These systems generally protect CCC at temperatures up to 1600 deg.C in air. Advanced gas turbine engine concepts require oxidation resistance in air up to 2000 deg. C and currently there are no coatings capable of providing such protection for CCC. The goal of this program is to explore new concepts of protecting CCC from oxidation in the 1600 - 2000 deg. C temperature range.

During the Phase I program, research will address new protection concepts based either on total prevention of oxygen contact with CCC or ones allowing some contact in conjunction with the removal of the corrosion product (carbon monoxide).

During the Phase II effort, the Phase I concept will be further developed to provide coated CCC engine components and a demonstration of oxidation resistance in tests simulating high temperature service.

N90-316   TITLE: Very High Framing Rate Digital Camera

CATEGORY: Research

OBJECTIVE: To develop a high framing rate camera for use in mechanics measurements systems.

DESCRIPTION: The capabilities of numerous instruments for mechanics measurements are limited by the low framing rate of current video camera systems. Fluid measurement systems, including planar laser induced fluorescence (PLIF), particle image velocimetry (PIV), and planar Rayleigh scattering, are not capable of sufficiently fine time-resolved measurements and their extension to three-dimensional flows is restricted by the framing rate. Similar needs exist in solid mechanics in the areas of underwater explosions, dynamic fracture, high strain rate testing, impact and stress wave analysis.

The currently available cameras that operate at framing rates of the order of 1 million frames/sec can only store a limited number of frames (generally <20). High speed video systems have a maximum framing rate of 2000 frames/sec. The envisioned digital camera would use a parallel architecture to write image frames directly into computer memory and have the following characteristics:

512*512 Pixels
8 to 12 bit resolution
100K to 1 million frames/sec
100 - 1000 frames

A camera with these characteristics would have broad applications in engineering and science.

During Phase I, research will address various conceptual parallel architecture schemes, devices and circuits for achieving high framing rates.

During Phase II, one of the concepts will be further developed into a high speed digital camera demonstration in conjunction with one of the above applications.

N90-317   TITLE: Neural Network Applications for Nondestructive Inspection of Aircraft

CATEGORY: Research

OBJECTIVE: To develop new neural network approaches for use in automation of non-destructive inspection of aircraft.

DESCRIPTION: Aircraft reliability and maintenance studies indicate that inspections for aircraft structure/surface flaws resulting from corrosion, fatigue, or stress can be conducted relatively infrequently. However, when inspections do occur they require painstaking attention to detail, a large number of repetitive measurements and highly skilled pattern recognition capabilities. X-Ray sensors are employed to inspect for cracks, voids, porosity and inclusions, ultra-sonic sensors are used to detect cracks, delaminations, and porosity, and eddy-current detectors are used to evaluate fire damage and to detect surface cracks, pits, porosity and corrosion. Acoustic emission techniques also provide relevant information regarding the aforementioned material flaws. Methods for applying neural network based automatic pattern recognition using input from one or more (i.e., data fusion) of the above sensors are sought. In addition, neural network based systems and concepts for robotic sensor placement will also be considered.

During the Phase I program, research will address the use of neural networks applied to patterns generated by various aircraft inspection techniques.

During the Phase II effort, Phase I concepts will undergo real-world assessment of flaw detection in aircraft mainframes.

N90-318   TITLE: Embedded Transputer-Based System Design

CATEGORY: Research

OBJECTIVE: To develop design approaches and evaluation criteria for a transputer architecture and its interoperability with software based on the theory of concurrency.

DESCRIPTION: Transputer technology provides a means for the development of specialized high speed parallel computer systems. Unfortunately, these complex systems can be constructed without fully understanding their operational behavior. Moreover, transputer technology, programming languages, and simulations do not, by themselves, provide adequate assurances that important liveness and safety properties are satisfied, or that the best design has been developed. Recent developments in theories of concurrency, program transformation, formal analysis methods, algorithm design and mathematical semantics of languages

suggest feasible practical approaches to predicting the safety and liveness properties of transputer systems and for the evaluation of classes of design alternatives.

Phase I will produce a conceptual design of a transputer system for a signal analysis application containing demonstrable safety and liveness properties using the component methods described above.

Phase II will produce a research prototype system based on the Phase I design.

OFFICE OF NAVAL TECHNOLOGY

N90-319   TITLE: Non-toxic Antifouling Paint

CATEGORY: Exploratory Development

OBJECTIVE: Develop a maritime antifouling coating system that matches the 80 month overhaul cycle dictated by Navy policy. Further, because of environmental constraints that prohibit the use of organotin paints, the paint should be non-toxic to marine life.

DESCRIPTION: Fouled hulls present a severe problem for the Navy. Fouling can increase engine power needs by 25% just to maintain the speed attained from a non-fouled hull. An 80 month paint life adds 51.4 ship years of operational availability to current naval capability. Increasingly stringent environmental laws make it impossible to continue using copper based organotin paints. Present copper based paints are not effective against slime, algae or grass.

It is expected that Phase I will identify promising candidate paint systems and develop the rationale for proceeding to a Phase II feasibility demonstration on a small scale.

N90-320   TITLE: Shipborne/Airborne Target Extraction Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Develop of passive IR sensor for detecting low emission targets in a cluttered environment.

DESCRIPTION: The development of low probability of intercept radar and hard to detect targets have made passive shipborne acquisition of incoming threats extremely difficult. To successfully accomplish this task, sensors capable of extracting targets from cluttered backgrounds are needed. A promising technique for aiding in the extraction of these type targets is infrared on-focal plane signal processing. By eliminating pixel-to-pixel spatial content and using time varying content, effective target extracting can occur.

The first phase of this program calls for candidate infrared search and track sensors to be investigated and defined for both a shipborne and airborne applications.

The second phase will demonstrate relevant breadboard hardware.

N90-321   TITLE: Equipment Support Structural Concepts

CATEGORY: Exploratory Development

OBJECTIVE: Develop new beam and truss like supporting structural concepts that will be low in cost, simplified in joining assembly and capable of high strength. These are to be capable of being deployed unassembled in a compact volume for rapid assembly into strong, rigid structures in a variety of configurations.

DESCRIPTION: Navy applications can benefit from the development of field assembled structures to meet a number of emergency situations including ship damage control. In addition, these concepts could also be applied to reducing the costs of fabricating and assembling equipment support structures on ships and submarines. Attributes desired include: (1) Minimum parts and fasteners; (2) Capability of being assembled into a variety of beams and trusses from standard component parts; (3)Capability of being made of metallic, wood, or composite materials; (4) Simple and easy assembly into a variety of configurations; and (5) Capability of field assembly in minimum time. Proposed concept developments should include demonstrating feasibility conceptual designs including strength analyses of the basic elements in a number of configurations.

N90-322   TITLE: Methodology for Decision Making Processes

CATEGORY: Exploratory Development

OBJECTIVE: Develop a methodology which utilizes an "expert system" approach as an aid in the decision making process to help decide if or when Basic Research (6.1) on a particular concept or idea has been or will be conducted to a sufficient degree to warrant transition to Exploratory Development (6.2) and if the research findings and/or developmental objectives can be translated into functional applications.

DESCRIPTION: Conduct a study of advanced technology transition candidates such as magnetohydrodynamic (MHD) (to be provided by the Office of Naval Technology) identifying a technology base decision process and information inputs required to enable a successful 6.1 to 6.2 technology transition. Define the decision process and develop methods of prioritizing obstacles to this transitioning process. Explore expert decision aids, develop an expert system concept and define the information base required to support technology transitions.
        Phase I requires the identification and prioritization of the major obstacles, especially "show stoppers" which might prevent further development, as well as the selection and demonstration of a rational approach for the subsequent (Phase 2) development of such a decision aid.

U.S. MARINE CORPS

N90-323   TITLE: Fire Resistant Assault Suit

CATEGORY: Exploratory Development

OBJECTIVE: To develop a lightweight outer garment (jumpsuit) that will provide full body protection to 2000 degrees F for a period of no less than two minutes.

DESCRIPTION: Current "Flame Retardant" outer garments have a flash point well below 2000 degrees F and are generally constructed of synthetic fibers which cause secondary and collateral injury at high temperatures. A need exists for a garment with a high resistance to flame that is lightweight and will not restrict body movement. The suit should be able to be worn during normal military raid missions which may require parachuting, boating, repelling and swimming.
        Phase I would be development of prototypes for evaluation for performance specifications.
        Phase II would be refinement of the design and field/user evaluation of a number of suits to specified Marine Corps units.

N90-324   TITLE: Noise-Eliminating Assault Radio Headset

CATEGORY: Exploratory Development

OBJECTIVE: To develop a headset that can be effectively used by Marine Corps assault and raid forces.

DESCRIPTION: Current headsets which interface with radios do not offer the user the ability to detect ambient sound as well as information passed over the radio. Likewise, current ear muffs which offer amplitude limiting sensing of ambient noise do nothing to excise broadband ambient noise of varying amplitude.   A need exists to develop a novel approach to a radio-interface headset which will allow a user to detect radio information and real-time ambient noise in both ears while excising broadband noise (boat engine, helicopter, generator), while eliminating damaging amplitude noise and while allowing low amplitude noise (voice) to pass to the user. Ideally, the headset will incorporate a capability to pick up user voice signals for transmission over the radio without the use of a boom microphone or external attachment.
        Phase I should develop hybrid prototype headsets that can be evaluated for future engineering to better meet required and desired specifications.
        Phase II will be the refinement of the design and delivery of test articles and results of laboratories tests designed to measure performance specifications.

N90-325   TITLE: Distributed Explosive Demolition Kit

CATEGORY: Exploratory Development

OBJECTIVE: Investigate and demonstrate the feasibility of developing an improved Explosive Ordnance Disposal (EOD) Demolition Kit utilizing existing and emerging technology in distributed explosives. Additionally, investigate and demonstrate the feasibility of utilizing distributed explosives to accomplish standard military explosives and demolitions tasks.

DESCRIPTION: EOD and standard military demolition tasks cover a broad range of situations and requirements. Present and emerging technology in distributed explosives may be used to increase and broaden present capabilities in these areas. Such technologies as foam and liquid explosives, ribbon explosives, and miniature shaped/plate charges are presently being developed for application in landmine neutralization.
        Phase I: This effort should provide an analysis of EOD and standard military demolition requirements. Distributed explosives candidates should be analyzed for potential application to specific military requirements with theoretical comparisons made between the capabilities of distributed explosives and existing EOD/Standard military demolitions munitions. Recommendations on further development of existing distributed explosives will be made.
        Phase II: This effort will include explosive performance modeling of specific distributed explosives as applied to military requirements. Distributed explosives will be procured and sufficient live testing conducted to demonstrate the feasibility of using specific distributed explosives to significantly improve present capabilities in EOD and standard military demolitions. Existing distributed explosives technology will be further developed as required to fulfill requirements. A final report will document analytical and test results and provide recommendations for use of distributed explosives in EOD and standard military demolitions.

N90-326   TITLE: Lightweight Automatic Agent Detector

CATEGORY: Exploratory Development

OBJECTIVE: To develop an inexpensive, reliable, lightweight, automatic agent detector with capability for remote (line-of-site) query and alarm. A version of the detector should be capable of flexible employment as a drop-off sensor to monitor remote areas for contamination.

DESCRIPTION: This SBIR effort will require that contractors have appropriate clearance, secret as a minimum. The detector must be sensitive to a wide range of toxic substances and specifically identify agent class. At a minimum, detectors should be able to directly or indirectly detect presence of G, V, HD, L, AC, CK, and CG type agents at acceptable levels and response time. The detector sensor should use proven miniature technology. Detectors should be considered expendable. Detector must be compact for attachment to clothing and equipment and lightweight. Proper function must be readily verifiable. Detectors must provide audible and visual alarms. Detectors are expected to perform from 125°F to -25°F. The detectors must be capable of unattended operation. Use of MIL-STD batteries is required. Detector sensors must be reusable and capable of quick clear down. Detectors must be capable of 24 hours continuous operation on batteries and have a shelf-life of approximately 5 years. Detector operation must not interfere with communications and electronics equipment used in a Marine rifle company.
        Phase I will focus on concept development for a lightweight automatic detector, a drop-off detector configuration, and line-of-site remote warning systems. Specification for detector sensitivities and response performance will be developed as a portion of the SBIR Phase I.
        Phase II and III will focus on fabrication, testing and refinement of prototypes.

N90-327   TITLE: This Topic Left Blank

CATEGORY:

OBJECTIVE:

DESCRIPTION:

NAVAL AIR SYSTEMS COMMAND

N90-328   TITLE: Electromagnetic Field Sensor for Application to Electromagnetic Compatibility Concerns

CATEGORY: Exploratory Development

OBJECTIVE: Develop a wide band electromagnetic sensor system capable of simultaneously and independently measuring the electric and magnetic fields at an air-to-metal boundary such as encountered on equipment outer casings or other primary electromagnetic shields.

DESCRIPTION: The proliferation of electronic technology is producing an increasingly crowded and hostile electromagnetic environment. At the same time, weapon systems platforms are more and more dependent upon survivable operation of computers, communications, navigation, and other electronic subsystems for successful mission performance. It is desirable to have a consistent means for assessing upper level operational electromagnetic environments to establish survivability criteria and for monitoring the environments of operational platforms to give warning when the survivability criteria are being exceeded. A small, light-weight sensor system and application procedures are needed to determine when inherent hardening criteria are exceeded.
          Phase I should produce a sensor prototype which uses available sensor technology and establish sensor calibration methods. Procedures for utilization in environmental assessment, equipment testing, and platform monitoring should be established.
          Phase II should apply the results of Phase I in developing the necessary sensor systems for application and integration into a specific weapons platform for assessment and testing.

N90-329   TITLE: Non-contact Dimensional Gauging

CATEGORY: Advanced Development

OBJECTIVE: Precision machining and grinding processes are designed to remove metal with an accuracy of 0.0002 inch or less. When cylindrical grinding is being performed the grinder must be stopped several times as the part is dimensionally inspected. Several measurements are necessary as the grinding wheel wears since infeed of 0.001 inch does not remove 0.001 inch of material. A device which reads changes in surface location would enhance productivity as well as optimize accuracies required.

DESCRIPTION: Current in-place measurement of parts being machined or ground is accompanied by measuring the original dimension, removing some metal, measuring the new dimension, removing more metal, measuring the dimension again, and so forth. This method is cumbersome, time-consuming, and the subject part is often machined too much and rejected. The proposed device would enable a remote, non-contact measurement to be taken before machining/grinding is begun. As the part has been measured by contact devices (micrometers, dial indicators, etc.) before machining begins, the original dimension is known, a desired   ount of metal will be removed to give the required final dimension, therefore, a change in dimension (delta) is the measurement taken. The metal removal process is then begun and will be able to be located up to three feet from the part and will have a demonstrated measuring accuracy of 0.0002 inch.
          Phase I will include an evaluation of currently available non-contact gauging methods (laser, ultrasonic, etc.). The ability of the methods to withstand machine shop environments and meet the demonstrated tolerance are prime considerations.
          Phase II includes development of the measuring device such that remote, one-sided measurements of surfaces (32 RMS or better) can be made. A digital readout is required.

N90-330   TITLE: Flight Simulator Visual System Recording/Evaluation Device

CATEGORY: Engineering Development

OBJECTIVE: To record the visual scenes from flight simulators while flown by pilots for later replay and analysis.

DESCRIPTION: Flight simulators have advanced visual systems which are tested and accepted by test pilots or experienced aircrew who fly the simulator. However, while flying the system, all aspects of the visual display may not be observed by the pilots. The pilots will often give overall impression of a problem with the visual display which will not provide enough information to the visual engineer to specify the problem with sufficient detail for correction. A visual recording system that can record the

entire field of view that the pilot sees in the simulator (often 180 degrees by 40 degrees) while he/she is flying the device will provide valuable test and acceptance information.

Phase I should consist of a study outlining the approach which will be undertaken to pursue the requirements addressed above with sufficient data to demonstrate feasibility.

Phase II should use the approach outlined in Phase I to develop and deliver to the government for testing a prototype system.

N90-331   TITLE: Miniaturized Solid State Computer Screen Display System with Interactive Voice Control

CATEGORY: Advanced Development

OBJECTIVE: Development of highly miniaturized and portable solid state computer screen display system which may be worn as modified eye-glasses and controlled by voice commands from the operator. Result will lead to the development of alternatives to current computer cathode ray tube or liquid crystal displays with keyboard control in space-restricted environments such as aircraft or submarines.

DESCRIPTION: Currently, almost all computer systems require bulky human interface devices (large screens and keyboards). In certain spaced-restricted applications such as aircraft and submarines, the benefits of advanced computer technology are foregone because of computer weight and space requirements as well as the lack of mobility for the operator. The development of a computer display system which could be worn as modified eye-glasses and controlled by the operator's voice would significantly reduce or alleviate these requirements and allow the application of computer technology in areas previously untouched by the computer revolution.

Phase I: Identification of existing "off-the-shelf" systems, both in computer solid state display technology and computer interactive voice control systems, as potential candidates for prototype development. Feasibility study and analysis of the effort to integrate the two technologies. Simple prototype development effort at the desktop computer level.

Phase II: Full scale effort to fully integrate and miniaturize the two technologies at a hand-held or belt-carried computer level. Development of demonstration hardware system. Development of demonstration software for two or three fleet applications such as training, maintenance routines, or technical documentation. System testing and evaluation by several designated fleet activities. Identification of system enhancements which would enhance fleet integration.

N90-332   TITLE: Determination of Edge Distance Requirements for Fastener Holes in Advanced Composite Panels

CATEGORY: Engineering Development

OBJECTIVE: To determine the edge distance requirements for installation of fastener holes in newly manufactured and repaired advance composites panels. Phase I is expected to be laboratory research, development, test and evaluation, followed by Phase II which will be a shop floor demonstration where test panels will be manufactured, repaired, tested, and evaluated with the ultimate goal of implementation of these determinations into aircraft composite panel manufacture and repair processes.

DESCRIPTION: The manufacture and repair of advance composite structures have serious problems connected with the placement of fastener holes. This is especially relevant to composite panel repair whether repairs have to be made in the field with a minimum of technical support or in a well-equipped and staffed repair facility. More research is required concerning the placement of fastener holes and edge distances in these structures, data has to be developed and the manufacturing and repair processes have to be established and expanded so that they can be implemented in the aviation maintenance environment. Not so long ago, research and development led to major gains in fastener technology, fastener placement, and revolutions in edge distance requirements and fatigue life increases in metallic structures. The same effort is needed for composite structures.

N90-333   TITLE: Laser Soldering Inspection System

CATEGORY: Advanced Development

OBJECTIVE: The objectives of this study should be two fold. First, to determine the limitations of both laser soldering and inspection systems. This would entail a comprehensive survey of literature and research facilities that center around the development and implementation of laser soldering and inspection systems. Second, to develop a laser soldering and inspection system that repeatedly provides highly reliable solder connections. This would entail developing a process that is capable of discriminating quality defects within the limitations of automated laser soldering and inspection.

DESCRIPTION: Printed Circuit Assemblies (PCAs) and other electronic components are used extensively in avionic systems requiring a high degree of reliability. PCAs are typically composed of a printed circuit board via solder joints. The solder joints are the fundamental mechanisms that ensure the structural integrity and reliability of the PCA. The purpose of this project is to assess and develop a laser soldering and inspection system that is capable of real-time statistical process control (SPC). The real-time SPC in an automated soldering system will provide timely response for correcting anomalies in manufacturing, thus proving more reliable PCAs.

The development of the laser soldering and inspection system is anticipated to be divided into two phases. Phase I will entail the development of an automated laser inspection process. This will encompass expanding or complementing work that has been accomplished thus far in the electronics industry. This phase will provide an exhaustive report on the causes of repeatability problems within the laser inspection process and recommendations for improvement that have been verified experimentally.

Phase II would involve the integration of the soldering system with the inspection system. A detailed study should be made to determine the critical parameters within the laser soldering system that will have an impact on the quality or reliability of solder connections. From this, algorithms could be developed that would provide real-time SPC capability using output from the laser inspection system.

N90-334   TITLE: Thickness Gauging of Complex Coatings on Turbine Components

CATEGORY: Advanced Development

OBJECTIVE: To develop a thickness gauge using Eddy Current or Beta-Backscatter technology to quickly and accurately determine the amount of coating present on turbine components. This system could be used to monitor coating processes and to evaluate coated blades and vanes while in engines.

DESCRIPTION: Eddy Current and Beta-Backscatter methods have been utilized for sometime to determine coating thickness on various alloys. The choice of method is most often determined by the system being evaluated, i.e. non-conductive coatings on conductive substrates, conductive nonferrous coating on ferrous substrates, etc. The Beta-Backscatter equipment currently available is typically a table top device in which the part is installed for testing. Eddy Current testers are often small portable devices which can easily be carried to the engine for part testing. Beta-Backscatter testers typically are more successful in evaluating conductive coatings on conductive substrates while Eddy Current testers are more successful in testing non-conductive coatings on conductive substrates.

Modern gas turbine engines contain the following material systems:
    (a) Thermal barrier coating on Nickel superalloys
    (non-conductive on conductive)
    (b) Carbide hard-face on Titanium
    (conductive on conductive)
    (c) Corrosion resistant coatings on Nickel superalloys
    (conductive on conductive)
    (d) Plating on stainless steel
    (conductive on ferrous)
Phase I will consist of evaluation of Eddy Current and Beta-Backscatter technologies to determine the optimum method to be employed.

Phase II will consist of purchase/development of the proper equipment for this evaluation. An end-effector probe will be developed in order to allow in situ testing. The "probe" must be capable of reading between surfaces 1/2 inch apart with convex and concave curvatures as little as 0.050 inch radius. Currently available "probes" require much flatter surfaces.

Thickness range for the coatings will be 0.001 inch to 0.030 inch.

N90-335   TITLE: Conformal UHF (SATCOM) Antenna for Tactical Aircraft

CATEGORY: Exploratory Development

OBJECTIVE: Conduct a study to investigate candidate conformal antenna configurations that have high potential for solving UHF SATCOM needs for aircraft. Fabrication of model units will be used to identify and validate pattern coverage and integration requirements for aircraft application.

DESCRIPTION: A need has been identified for extending the Navy aircraft communication nets beyond line-of-sight via satellite communications. This study will identify electrical and mechanical conceptual designs of conformal UHF SATCOM antenna for high performance Navy aircraft. Issues to be addressed will include viability of approach, aerodynamics, mechanical profiles and an assessment of potential technical risks. Fabrication of "breadboard models" will be used to evaluate and measure radiation patterns, power handling capability (100 watts), weight constrains, feasibility of flush mounted antenna and integration requirements for host platforms such as, F-14, F-18, EA-6A, E-2C and OV-10.

N90-336   TITLE: Aircraft Wheel Usage Indicator System

CATEGORY: Advanced Development

OBJECTIVE: To develop a simple, compact, resetable device attached to an aircraft wheel to measure accumulated usage from wheel installation to wheel removal. If successful, this device would be used to generate and enforce contractor warranties of wheel roll life.

DESCRIPTION: Currently, realistic, enforceable warranties are not used to ensure continued quality wheels are placed on aircraft landing gear. The reasons for this vary, but include: 1) existing systems are either bulky, heavy, or costly; 2) systems are either too simplistic or complicated and, therefore, do not accurately show true usage, or are not suitable for the intended maintenance level; 3) they do not indicate a valid parameter acceptable to both user and supplier. A proper Aircraft Wheel Usage Indicator System would be simple and durable in design to withstand the harsh landing gear environment, small and lightweight to fit within the tight wheel/brake and wheelwell envelopes, attached to the wheel and independent of the aircraft for simple flight line replacement, and resetable upon wheel disassembly to allow interchangeability between indicators, wheel assemblies, and wheel halves. It would show either accumulated miles, or wheel rotations which are convertible to miles (this might allow for possible placement on different type aircraft).
          Phase I should develop an optimal indicator to show the feasibility of accumulating and recording by wheel half the total miles rolled.
          Phase II should use the Phase I results and verify the feasibility by providing eight prototype units for installation and testing on an agreed upon Navy aircraft.

N90-337   TITLE: Aircraft Brake Usage Indicator System

CATEGORY: Advanced Development

OBJECTIVE: To develop a simple, compact, resetable device attached to an aircraft landing gear brake to measure accumulated usage from brake installation to brake removal. If successful, this device would be used to generate and enforce contractor warranties of landing gear brake life.

DESCRIPTION: Currently, realistic, enforceable warranties are not used to ensure continued quality brakes are placed on aircraft landing gear. The reasons for this vary, but include: 1) the extreme operating environment (high/low temperatures) make any system of measurement difficult; 2) systems are either too simplistic or complicated and, therefore, do not accurately show true usage, or are not suitable for the intended maintenance level; and 3) they do not indicate a valid parameter acceptable to both user and supplier. A proper Aircraft Brake Usage Indicator System would be simple and durable in design, able to withstand the harsh landing gear environment, small and lightweight to fit within the tight wheel/brake and wheelwell envelopes, attached to the brake assembly and independent of the aircraft for simple flight line replacement, and resetable upon brake assemblies. It would show accumulated stops, with the ability to distinguish between low energy stops (taxi), normal energy stops (full stop, normal landing weight aircraft), and high energy stops (full stop, overweight aircraft).
          Phase I should develop and propose an optimal indicator system to show the feasibility of accumulating and recording by type the total number of stops. The system should be developed for use on a carbon composite heat sink brake assembly.
          Phase II should use the Phase I results and verify the feasibility by providing eight prototype units for installation and testing on an agreed upon Navy aircraft.

N90-338   TITLE: Non-asbestos Replacement Materials for Navy Aircraft

CATEGORY: Engineering Development

OBJECTIVE: Asbestos materials are currently being used in a variety of applications on Naval aircraft. Many of the applications are gaskets used throughout the powerplants system. Due to a recent Environmental Protection Agency (EPA) ruling that will phase-out manufacturing and processing of asbestos in the United States, adequate replacements for asbestos parts on Naval aircraft, especially gaskets, must be identified and qualified, or developed.

DESCRIPTION: Non-asbestos replacement materials such as gaskets used in Navy aircraft powerplants systems must be fully qualified. Adequate replacement materials may be commercially available but these materials must go through a series of evaluations to determine their suitability. If no suitable non-asbestos replacements exist, then these materials must be developed.
Phase I would involve a thorough survey to identify all commercially available replacements.
Phase II would involve material screening tests and performance testing of the top candidate materials. A program of this nature would provide non-asbestos replacement materials and adequate supporting data that will enable NAVAIR to comply with the EPA directive which will ban the supply of asbestos sheet gasket materials by August 1993.

N90-339   TITLE: Low-cost Electronic Warfare Response Monitor

CATEGORY: Exploratory Development

OBJECTIVE: To develop a low-cost approach to provide enhanced missile defense training to Navy electronic warfare personnel. This enhanced training can be achieved by the integration of an electronic warfare response monitor into existing flyable missile simulator pods. This response monitor would receive and record electronic responses to threat missile simulators. The data would be used for post mission analysis and increased training effectiveness.

DESCRIPTION: The AN/AST-6 threat missile simulator pod being procured under a PMA-212 program will provide the fleet with an urgently needed training asset. It can be carried on a variety of Navy aircraft and will replicate a wide-range of threat missiles. Although it is a valuable asset, it will have some limitations. The present AN/AST-6 does not have the capability to monitor electronic countermeasures/tactics used to defeat threat missiles. The capability of the AN/AST-6 can be improved by the development of a low-cost electronic warfare response monitor. The response monitor would consist of a receiver/recorder to provide for post-mission analysis. The response monitor must be small, relatively simple and low in cost.
The Phase I program should investigate low-cost approaches and propose a Phase II demonstration program. If this development program is successful, PMA-212 will integrate the electronic warfare response monitor into production AN/AST-6 missile simulators and provide the fleet with enhanced training.

N90-340   TITLE: Advanced Armament Stubwings for Marine Attack Helicopters

CATEGORY: Advanced Development

OBJECTIVE: Develop a state-of-the-art armament stubwing assembly which permits two additional wing stations, providing the capability to utilize anti-armor and air-to-air weapons, and to incorporate other needed improvements, to meet the threat in future Marine attack helicopter combat environments. Explore technology to allow integration of new weapons without rewiring the wing stations for each new system. Explore the potential of adding weapons stations on the upper surface of the wing to allow launch of Sidewinder, Sidearm and/or Stinger. This effort should also explore alternate landing gear systems to the present skid system.

DESCRIPTION: The U.S. Marine Corps, through new development and a block modification program, will achieve an all AH-1W attack helicopter fleet by the early 1990's. This aircraft must remain capable of meeting the threat well into the 21st century. Because the design of the current armament stubwing assembly is based upon antiquated technology, the armament carrying capability of the weapon system is being far outpaced by requirements to carry new and advanced weaponry as the threat dictates. This situation has given rise to the need for development of a new, state-of-the-art stubwing assembly that retains all of the capabilities of the current configuration, as well as incorporation of the following: 1. The system would be fully integrated. 2. Advantage would be taken of the recent advances in composite material technology. (The weight of the assembly would be reduced as a result of this application). 3. The system would have two additional weapons stations, while maintaining structural integrity under increased loads during Airborne Combat Maneuvering. 4. The aerodynamics of the system would provide lift or impose zero drag penalty. 5. Materials used should enhance the overall survivability of the aircraft. 6, Explore technology integrating new weapons without rewiring wing stations. 7. Explore the potential of adding addition weapons station on the upper surface of the wing to allow launch of such weapons as Sidewinder, Sidearm and/or Stinger. 8. Investigate alternate landing gear systems to the present skid system.

Phase I of this effort will consist of a design study exploring the incorporation of the improvements discussed above.

Phase II of this effort will develop a conceptual design of a new stubwing, including a mockup.

DATA that can be provided to potential offerors:

1. Schematic drawings of the current stubwing assembly.

DATA that can be provided during Phase I: 1. Government drawings of the present stubwing and aircraft attachment points. 2. Visits to NAVAVNDEPOT, Pensacola, FL the AH-1W rework activity will be arranged to allow first hand examination of the aircraft stubwing attachment points. 3. Other data will be provided on an as needed basis.

N90-341   TITLE: Electro-Optical (E/O Infrared (IR) and Multi-mode Missile Countermeasures

CATEGORY: Exploratory Development

OBJECTIVE: To develop improved electro-optical and infrared missile countermeasure techniques and concepts.

DESCRIPTION: Currently available Missile Warning Receivers possess an ability to detect and provide warning of hostile aircraft/missiles. Current flares, chaff and on-board countermeasures will continue to face an ever increasing and sophisticated threat in terms of both technical complexity and size. Improved countermeasure techniques and concepts which would enhance own force survivability and would effectively counter this threat is what the Navy desires to improve. A study to explore alternative E/O and IR missile countermeasure (for both on-board and off-board) techniques and/or concepts is desired.

Phase I study and or demonstration must address feasibility and all technical risk factors.

Phase II should demonstrate concept outlined in Phase I utilizing prototype hardware/processes.

N90-342   TITLE: Integration of Advanced Technology Components for Airborne Electronic Warfare (EW) Applications

CATEGORY: Exploratory Development

OBJECTIVE: Several on-going technology development efforts eg. MIMIC, VHSIC, conformal antenna arrays, GaAs digital radio frequency memories, massive parallel processing, fiber optic interfaces etc. provide significant performance advantages over current component technologies. To realize the performance gain these component technologies offer they must be integrated into new subsystem architectures which can effectively utilize the speed, power and size of the various components. Phase I should identify candidate projects and prepare subsystem architecture designs for potential implementation in Phase II.

DESCRIPTION: DoD has invested a significant amount of funds into the development of these technologies, with some of these technologies proceeding into their second decade of development. The identification of onboard, offboard and integration projects which can utilize these technologies effectively is critical in establishing the production volume needed for economic realization. Phase I should utilize a bottoms-up approach that considers first the utilization of advanced technology to satisfy operational and technical requirements. The integration of these technologies is expected to result in the development of more effective coordinated ECM techniques, affordable channelized receivers with the sensitivity and broadband coverage needed in surveillance and threat warning receivers, and the implementation of stealthy antennas in conformal (smart skins) and shared aperture arrays. MIMIC technology makes possible the economical use of numerous transmit/receive modules necessary in antenna arrays and the use of on-board/off-board pulse and noise ECM techniques. VHSIC and parallel processing techniques provide the speed and processing capability to handle the volume of data and control signals.

Phase I should evaluate the application and availability of advanced technology modules into selected subsystem architectures.

Phase II should provide the specification requirements and detail design for follow-on advanced technology demonstration of a specific subsystem.

N90-343   TITLE: Application of Operations Research Systems Analysis Techniques to Quantitatively Assess Emerging Electronic Warfare Related Technologies

CATEGORY: Advanced Development

OBJECTIVE: Identify and develop operations research systems analysis techniques which provide decision makers quantitative tools for evaluating the potential operational benefits derived from emerging technologies. The successful implementation of this effort would result in the development of investments strategies in technologies that offer the highest technical and operational

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payoff. The application of these quantitative tools can be used in evaluating and sponsoring contractor IR&D, balanced technology initiative, SBIR's, advanced technology demonstrations, basic research and exploratory development efforts.

DESCRIPTION: The methodology for the quantitative evaluation process should be established during Phase I. Assignment of relative values and weights to numerous factors such as technical merit, operational effectiveness, risks, and cost will provide the input variables in assessing competing technologies. The operations research systems analysis techniques to be developed should allow the evaluation of the various technologies in enhance electronics warfare (EW) and EW's contribution to the various Navy missions and Top Level Warfare Requirements (TLWR's).

Phase I results should recommend the operations research technique to be used and describe the utilization of various experts to identify the various technologies and to identify real-world programmatic and operational issues including the assignment of relative values and weights to the input variables.

Phase II should develop the algorithms and software programs including the analytical factors and programmatic considerations into a ruled based expert system. The objective is to make these analytical tools available to program managers and sponsors thus the implementation of these software programs should be compatible with available desk top personal computer systems.

N90-344   TITLE: Short Term Stability Attainment Device with Minimal Oscillatory Signature

CATEGORY: Exploratory Development

OBJECTIVE: Development of foundational parameters for the design of an advanced technology personnel parachute for premeditated airdrop and emergency use.

DESCRIPTION: The need exists for research leading to the development of a device that will attain aerodynamic stability within an altitude differential of 250 ft. after having exited from an aircraft with velocity of 150 KIAS and will exhibit an oscillatory signature of less that +/- 10 degrees. Said device must deliver a load of 300 pounds to the earth's surface with an impact of no greater than 52,000 ft lbs/sec/sec. Force loads of less than 6 G's imparted on the load during the stabilization event are desired. Packaging of the device cannot exceed 9500 ccm at atm.

Phase I will develop aerodynamic shapes and mathematical models to provide Cd derivation; pre-stabilization load predictions; pressure distribution prediction; and computational structural analysis are of particular interest.

Phase II is intended to construct and demonstrate shapes predicted by the math models as having highest potential of achieving the objective.

N90-345   TITLE: Advanced Fire Extinguishant Development

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate the science of chemical extinguishment of fires and characterize the extinguishment mechanisms of various known firefighting agents. Propose new methods and materials for enhancement of agent effectiveness and firefighting capability.

DESCRIPTION: The extinguishment of fires can be accomplished both physically and chemically. Water based agents are effective mainly due to the physical cooling effect and the separation of oxygen from the fire. Reactive chemistry is used for more effective extinguishment due to heat generated reaction of the agent with available oxidizers. Such an extinguishment mechanism is said to make Halon agents effective. The currently used Halon fire extinguishants are expected to be eliminated in the future due to their effect on the depletion of the ozone layer, hence the need for further understanding of fire extinguishment phenomena.

An innovative research effort is required for the purpose of identification and characterization of various fire extinguishment mechanisms. An increased understanding of the nature of what is needed to support or suppress fire can lead to improved firefighting or fire suppressing agents and methodologies.

Phase I will address extinguishment mechanisms and effectiveness.

Phase II efforts will utilize the information found in Phase I for the purpose of designing a next generation firefighting and fire suppressing agent as well as generating a list of candidate agents for the replacement of Halon 1211 and 1301. The contractor should plan one trip to NAVAIR to gather information relative to parallel HALON efforts within the Department of Defense.

N90-346   TITLE: Utility of Enhanced Maneuverability for Tactical Aircraft

CATEGORY: Exploratory Development

OBJECTIVE: To develop a means of evaluating the tactical payoff of Enhanced Fighter Maneuverability (EFM) technologies.

DESCRIPTION: The X-31 aircraft, the flight demonstrator for the EFM program, will have the capability of flying at angles of attack well beyond current operational aircraft. The ability to yaw the aircraft in the post stall flight regime implies, intuitively, a significant advantage in adversary engagements. However, for enhanced maneuverability to become an operational requirement this advantage must be quantified and shown to be useful for specific Naval applications. Thus, a methodology for evaluating enhanced maneuverability as demonstrated by the X-31 for potential tactical benefits is needed.
        Issues that must be addressed for effective transfer of EFM technologies concern basic configuration differences between the X-31 and Naval Tactical Aircraft. For example, carrier based aircraft typically do not have highly swept wings because of low angle of attack landing requirements. A methodology is required to extrapolate the utility of the EFM technologies and their tactical benefits to other airframes and specific tactical missions, e.g., Close Air Support and Battlefield Air Interdiction. Additionally, new tactics must be developed which take advantage of enhanced maneuverability, for various engagements such as a 1 versus 1 and a many versus many. This information is critical to effective planning of future R&D programs in this area.
        Phase I will involve selecting or developing an appropriate approach for measuring the tactical utility of the X-31 and a means of extending that information to other Navy airframes. Select examples will be looked at to demonstrate this methodology. A review of the X-31 flight test program and a plan for using the acquired data will be a deliverable in this phase.
        Phase II involves evaluating Naval missions to identify specific improvements in aircraft agility that will be most beneficial. The methodology of Phase I will also be used to develop tactics which will benefit from the more agile aircraft of the future.

N90-347   TITLE: Enzymatic Deterioration and Removal of Aircraft Coatings

CATEGORY: Exploratory Development

OBJECTIVE: Isolate and characterize the enzymatic process used by microorganisms for the degradation of polyurethane paints. Develop a process for producing such enzymatic activity on a large scale.

DESCRIPTION: Field activities generate large amounts of hazardous waste materials from chemical paint stripping processes. An environmentally safe aircraft paint removal process is greatly needed that will attack polyurethane coatings without generating a hazardous waste.
        Micro-organisms have been isolated that are capable of consuming and degrading some polyurethane coating materials. As an environmentally safe paint stripping process, this direct microbial action is slow. However, successful isolation of the biomolecular activity that attacks polyurethane may result in a more rapid coating degradation and removal process. An innovative development project is needed that makes use of known microbiological activity with polyurethane materials and enhances the activity by isolating the functional biomolecules necessary for such microbial activity.
        Phase I efforts will address the biomolecular isolation process from polyurethane degrading micro-organisms.
        Coating removal effectiveness and potential for scale-up will be addressed during Phase II.

N90-348   TITLE: Fiber Optic Research for Military Uses

CATEGORY: Basic Research

OBJECTIVE: To investigate and make specific recommendations on maintenance, supportability, testability, and logistic policies for fiber optic hardware components such as fiber cables, single and multi-channel connectors, fiber optic access couplers, cables, data bus structures, transmitters, and receivers.

DESCRIPTION: Fiber optics will be used in new and upcoming aircraft. Existing technology has demonstrated uses for fiber optics in guided weapons, high speed data buses, and "fly-by-light" concepts for aircraft. Currently, testing programs to research maintainability, supportability, testability, and logistic needs of fiber optic hardware components has been slow to develop.

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Research in these areas is necessary now, so that current and future policy decisions in these areas can be made with knowledge and confidence.

Phase I should consist of a general research study covering the specific areas of maintainability, supportability, testability, and logistic needs of fiber optic components. At completion of Phase I the government will receive a summary, conclusion, and recommendations for each policy area covered.

With favorable results from Phase I, Phase II should be more in-depth research including lab experiments and field studies to make specific recommendations as to types of fiber optic hardware components to be used in military aircraft and what are the best maintenance, supportability, testability, and logistic policies to be used on these items.

N90-349   TITLE: Prevention of Electromagnetic Pulse Effects on Fiber Optic Connectors

CATEGORY: Basic Research

OBJECTIVE: To investigate ways to make fiber optic connectors less susceptible to the effects of electromagnetic pulses (EMP).

DESCRIPTION: Fiber optics are currently being used for minor operations in today's aircraft and are going to be used more extensively in the future. Most fiber optic strands themselves are not susceptible to EMP, but EMP radiation can enter the fiber through the connectors and render it useless. For this reason, research in ways to make fiber optic connectors less susceptible to EMP effects is necessary.

Phase I should consist of a general research study covering ways to specifically improve current and future fiber optic connectors against EMP effects caused by equipment of enemy hostile forces or from nuclear detonation. At completion of Phase I the government will receive a summary, conclusion, and recommendations for making fiber optic connectors more EMP resistant.

With favorable results from Phase I, Phase II would be a more in-depth study of how to prevent EMP effects in fiber optic connectors. Lab experiments and field studies will be included in this phase to help make specific recommendations on how to improve fiber optic connector designs and how to shield current connectors in use against EMP effects.

N90-350   TITLE: Built-In Test Circuitry for Fiber Optic Systems

CATEGORY: Basic Research

OBJECTIVE: To investigate and make specific recommendations on built-in test (BIT) circuitry for application to fiber optic systems in avionics for primary diagnosis of failing components in the system.

DESCRIPTION: With the use of fiber optics in new and upcoming aircraft increasing, the need for ways to better diagnose fiber optic system component failures has increased. The use of BIT circuitry would improve the level of failure isolation in fiber optic systems and decrease repair and maintenance time. BIT circuitry would also help to reduce peculiar ground support equipment.

Phase I should consist of a general research study analyzing possible BIT circuitry configuration, uses, and equipment. After the completion of Phase I, the government will receive a summary, conclusion, and recommendations for the implementation of BIT circuitry to fiber optic systems.

If there are favorable results from Phase I, Phase II would be a more in-depth research of BIT circuitry including lab and field experiments using fiber optic systems. From this research specific recommendations for types of BIT circuitry equipment, design, and uses for fiber optic systems would be made.

N90-351   TITLE: Artificial Intelligence (AI) and Neural Network Technologies for Mission Planning and Execution
                 Applications

CATEGORY: Exploratory Development

OBJECTIVE: To apply advanced AI and Neural processing techniques to solve mission planning and execution problems which will improve mission effectiveness, reduce aircrew workload and improve operational readiness.

DESCRIPTION: Many manual mission planning and execution tasks could be automated or assisted by the use of artificial intelligence or expert system technologies. With the advances made in processing technology, this automation can be accomplished

economically at low to medium risk. The purpose of this effort is to demonstrate the application of AI and Neural processing to mission planning and execution problems and to observe the benefits obtained. Offerors should propose specific technologies to be used along with a specific mission problem to be addressed. The challenge is to derive maximum benefits from these emerging technologies and provide proof of principle with potential to transition a resulting new system or provide current system improvement for the users within the next five to fifteen years.

Phase I includes assessment of potential mission planning and execution tasks for automation and identification of promising hardware and software technologies.

Phase II would result in demonstration of the concepts generated in Phase I with consideration for further development and transition to advanced programs.

N90-352   TITLE: Aircraft Integrated Navigation Processing Technology

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel techniques to integrate digital navigation data.

DESCRIPTION: Stand-alone navigation sensors and subsystems are labor intensive, requiring a human navigator's blending and interpretation of data. The time constraints of modern warfare engagements require automated integration of high density digital navigation data from many sources in order to capitalize on the synergism and fault tolerance potential of using multiple navigational aids. The overall objective is to study, design, and develop novel techniques that optimally combine the information from complementary navigation sources using statistical and time-dependent criteria. Both adaptive digital and analog techniques should be considered. The integrated system is to provide benefits in navigation accuracy, mission reliability and operational efficiency. An initial survey should consider work done to date in integrating inertial, Global Positioning System (GPS), doppler radar, and air data hardware. Adaptability to different avionics suites and missions is an important consideration, since the outputs are to be used for flight control and mission surveillance/targeting/strike avionics in addition to the basic navigation function.

N90-353   TITLE: Shallow Water Anti-submarine Warfare (ASW) Sensor

CATEGORY: Exploratory Development
OBJECTIVE: Devise a novel method of detecting submarines in shallow water.

DESCRIPTION: Recent advances in submarine technology, including significant reductions in noise emissions, the use of sound absorbing coatings on submarine hulls, and the use of non-magnetic materials in submarine fabrication have greatly reduced submarine detectability. These submarine technological advances are reinforced in the shallow water operating environment. Sound reverberations in shallow water serve to quickly obscure returning echoes from sonar and obscure submarine signatures within the noisy background. Shallow water turbulence and suspended particulates reduce the usefulness of laser and other optical sensor surveillance methods. Magnetic materials suspended in run-off water and the nearness of mineral deposits to the surface reduce the usefulness of Magnetic Anomaly Detection (MAD) of submarines in shallow water.

The Navy is seeking new submarine acoustic or non-acoustic detection methods for use in shallow water. The methodology should be useful on both nuclear submarines and diesel submarines operating under battery power. The concept must not be currently in use or under investigation by the Navy.

The Phase I study should clearly address feasibility, anticipated cost, and detection levels achievable by the proposed method. The proposal should also include an outline of a proposed Phase II demonstration of the concept.

N90-354   TITLE: Long Range Anti-submarine Warfare (ASW) Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Devise a novel long range method of detecting deeply submerged submarines.

DESCRIPTION: The traditional methods of long range submarine detection are by active sonar/echo detecting, passive sonic arrays, and by satellite surveillance. The effectiveness of traditional methods of submarines detection has been greatly reduced by recent advances in submarine technology including significant reductions in noise emissions, the use of non-magnetic materials in submarine fabrication, the use of sound absorbing coatings on submarine hulls, and the ability to operate at great depths.

A new concept is sought for the long range (in excess of 100 nautical miles) detection of submarines traveling in the open ocean at great depth (in excess of 500 feet). The concept must not be currently in use or under investigation by the Navy.

The Phase I study should clearly address feasibility, anticipated cost, and detection levels achievable by the proposed method. The proposal should also include an outline of a proposed Phase II demonstration of the concept.

N90-355   TITLE: High Brightness Cockpit Displays Using Field Emit Array (FEA) Or Similar Integrated "Cold"
                 Electron Source Technologies

CATEGORY: Research

OBJECTIVE: Solicit creative approaches to processing and microfabrication research related to the development of pixel size integrated "cold" electron sources such as Field Emitter Arrays (FEAs) for eventual use in high brightness cockpit displays.

DESCRIPTION: Cockpit displays are presently dominated by Cathode Ray Tube (CRT) technology which is based on thermionic cathodes. Cathodes have several weaknesses: (1) bulky and require relatively large volumes of cockpit space; (2) require heater power from heavy and bulky power supplies; (3) are susceptible to implosion and other impact destruction; (4) require non-linear deflection magnetic fields and complex alignment circuitry for high spatial resolution color. Liquid Crystal Displays (LCD's), Plasma Displays (PD's), and Electroluminescent Displays (ELD's) have similar weaknesses. The major strength of CRT's is catholodoluminescence which has extremely high brightness and dynamic range, full color, high spatial resolution and no penalty in viewing angle. The possibility of microelectronic integrated "cold" electron sources which can be x-y addressed promises flat panel cathodoluminescent displays which have all the advantages LCD's, PD's, and ELD's coupled with the unique strengths of CRT's mention above. The electron source technology could be FEA's or any other suitable integratable "cold" microminiature low voltage electron source.

N90-356   TITLE: Application of Dynamic Lift for Enhanced Maneuverability

CATEGORY: Basic Research

OBJECTIVE: Development of a model for analyzing dynamic lift for enhanced maneuverability of tactical aircraft.

DESCRIPTION: The objective of the Navy Advanced Aircraft Systems Program is to demonstrate technologies and capabilities that are critical in attaining performance , maneuverability , and survivability for future Navy aircraft. As part of this program, NAVAIR currently is coordinating and supporting projects to exploit dynamic lift for enhanced fighter maneuverability. It is postulated that dynamic lift be can used for pitch and yaw moments enhancement, especially advantageously in flights at high angle of attack or under high "g". A limitation to the use of dynamic lift is the limited amount of time which this flow condition can be maintained.

While research towards developing stable vortex flow is ongoing, both analytically and experimentally, a basic understanding of the phenomena of vortex-dominated flows is crucial to this objective. The formation of a vortex, the essence of the dynamic lift phenomena, is a highly viscous flow situation where laminar to turbulent flow transition, flow reversal, and separation are occurring very rapidly . To be successful in applying dynamic lift a computational tool is needed.

An innovative approach to modeling dynamic lift which will account for the viscous effects and provide insight for more effective control is required. It is important that the proposed approach have a reliable transition model and be able to analyze regions of separated flow.

Phase I will concentrate on evaluating the state-of-the-art in numerical modeling of unsteady aerodynamics and propose an innovative approach for further research. It is important that any proposed effort be well orchestrated with ongoing research in this field.

Phase II will require implementation of this approach for development of a computational tool for dynamic flow control application.

N90-357   TITLE: Assessment on Composite Impact Damage Technology Development

CATEGORY: Exploratory Development

OBJECTIVE: Conduct a comprehensive assessment on the technology development efforts related to Aircraft Battle Damage Repair (ABDR).

DESCRIPTION: Composite materials are used for current navy aircraft and will be extensively used on the next generations of advanced aircraft. The knowledge of mechanisms, assessment methodology and repair techniques of composite damage from impact are being developed. However, to apply this knowledge for ABDR, many technical issues related to logistics, fleet operation and aircraft performance arise. Technologies required for ABDR are: Nondestructive Evaluations (NDE) methods for damage measurement, testing and modeling techniques for damage evaluations, materials for repairs and characterization techniques (testing and simulation) for performance evaluation of the repair articles.

Phase I effort will be an assessment on ABDR related technologies. The contractor will review 311 technology areas listed above. A report will be provided to identified technologies, programs, and performance organizations.

The Phase II is comprised of two parts. The contractor is expected to collect ABDR requirements unique to fleet logistics and operation through active interaction with navy fleet personal. Based on the requirements and the technologies identified from the Phase I effort, the contractor will develop a road map for the ABDR technology development. The second part of the Phase II effort is to develop and assemble computer simulation codes for NDE measurement technique development, damage assessment and structural performance evaluation of the repair articles. Presently, there are codes which address related technologies but none can be used for ABDR applications without extensive modifications.

N90-358   TITLE: Surface Residual Stress Analysis of Metals and Alloys

CATEGORY: Exploratory Development

OBJECTIVE: Develop a technique and associated equipment capable of quantitative evaluation surface residual stresses in metallic naval airframe materials without the use of ionizing radiation.

DESCRIPTION: Naval aircraft operators must rapidly and quantitatively evaluate the condition of aircraft structural materials in the operational environment of an aircraft carrier. One airframe problem has been the evaluation of surface residual stresses in both ferrous and nonferrous airframe alloys in a way that can be rapidly and safely applied to aircraft in the field and on board carriers. Although x-ray analysis techniques are a proven, effective and quantitative method for residual stress evaluation, they are difficult to apply in restricted areas and are limited by safety considerations. Recently developed procedures using either ultrasound or magnetic hysteresis have been successfully applied to the determination of residual stresses under favorable conditions. Generally, ultrasound techniques have been limited by textural uncertainties, and magnetic techniques have been only applicable to ferromagnetic alloys.

An innovative effort is sought to address these problems in the application of novel approaches to the quantitative analysis of surface residual stresses in both ferrous and non-ferrous alloys. Priority will be given to responses that at least in concept can evaluate stresses in both ferrous and non-ferrous alloys. The potential degree of quantitativeness in the technique will also be an important aspect of selection. Finally, the potential for the development of manually portable equipment to perform the analysis will be evaluated for eventual utilization in the navy aircraft fleet environment. Specific materials on which the technique may be demonstrated are at the discretion of the offeror. Several baseline materials that should be considered, however, are aluminum alloy 7075-T6 and/or 7050-T73, titanium alloy Ti-6Al-4V mill annealed and steel 300M(MIL-S-8844C).

Phase I should evaluate appropriate concepts, and Phase II should develop and demonstrate prototype residual stress equipment at least in the laboratory.

N90-359   TITLE: Thermal Stability Enhancing Additive for JP-5 Fuel

CATEGORY: Advanced Development

OBJECTIVE: Development of an additive that will increase the stability of JP-5 fuel at elevated temperatures without deteriorating the performance of the fuel.

DESCRIPTION: Future generations of gas turbine engines for naval aircraft and missile application have strong requirements for high specific thrust ratios and low specific fuel consumption. In order to meet these goals, gas turbine engines must operate at significantly higher temperatures and pressures. Currently used JP-5 fuel (narrow cut kerosene jet fuel) will oxidize prematurely at the elevated temperatures anticipated in the new turbine engines. Additive technology exists that will extend the elevated temperature stability of jet fuel but does not stabilize the fuel at the very high inlet temperatures expected. Also, such technology

deteriorates other performance properties of the fuel such as water-shedding ability, low temperature characteristics, filterability, and ignition quality.

An innovative additive development effort is required to address the problem of premature oxidation of the fuel due to the high temperatures expected in future generation gas turbine engines. The additive must be compatible with JP-5 fuel in that it does not degrade the important properties of the fuel. In addition, contaminant pickup from shipboard CuNi aviation fuel systems has been shown to degrade the thermal stability of JP-5 and must be addressed in the development.

Phase I efforts should demonstrate the stability enhancing chemistry necessary for high temperature JP-5 performance.

Phase II covers the formulation of doped JP-5 fuel and demonstration of high temperature stability improvement over undoped fuel. Contractor should plan one trip to NAVAIR/NAPC to gather information relevant to fuels and additive technology.

N90-360   TITLE: Cruise Missile Survivability Enhancement Through Deceptive Electronic Countermeasures (ECM)

CATEGORY: Engineering Development

OBJECTIVE: Develop a compact deceptive ECM device for use on cruise missiles to enhance survivability against defensive RF missile systems.

DESCRIPTION: Tomahawk missiles, when employed, will fly within the operating envelope of enemy RF anti-air missiles. Although the RCS of Tomahawk is low, it is likely that RF missiles will be used against Tomahawk. It may be possible that a deceptive RF device carried by Tomahawk can decoy the defensive missile or deny the fire control radar rage thereby causing the defensive missile to miss Tomahawk.

Phase I should consist of analytical first order predictions of performance against direct system and hardware form, fit, and function estimates for compatibility with the Tomahawk missile.

Phase II should include delivery of a prototype device and detailed performance predictions.

NAVAL SEA SYSTEMS COMMAND

N90-361   TITLE: Incentives for Manufacturing Technology

CATEGORY: Exploratory Development

OBJECTIVE: Delineate the knowledge nodes as necessary to incentivise the use of appropriate manufacturing technology into the military sector of the U.S. Industrial Base.

DESCRIPTION: The U.S. Navy has long been vitally interested, if not directly involved in, maintaining a core of domestic shipyard capability. Tacitly with this duty goes there requirement to achieve this goal with a minimum amount of public expenditures. Similarly, problems can be expected in attaining this objective as a result of predictable reduced demands based on budget cuts for military industries.

Present production models associate reduced demands with increased unit cost, which is true if we assume constant manufacturing technology. However, modern flexible manufacturing technology has demonstrated that quantity reduction and unit cost reduction can go together. Hence, it is justified to assume the possibility of an under-proportional output cost versus budget cut, provided sufficient incentives exist to modernize the manufacturing technology in the military sector of the industrial base.

However, manufacturing technology does not exist in a vacuum by itself. It must be seen in its interdisciplinary connectiveness with the economy and legal environment. The intrinsic interwoven aspects of technology, economy and law apply to the wide spectrum from international competitiveness to preparedness and surge. Conceptually, the nature of the problems are the same; only the terminology changes: It is the concern with the well-being of the U.S. Industrial Base.

A pilot study is requested, centered on incentives for manufacturing technology and delineating relevant economic and legal aspects and knowledge nodes to gain the benefits of technological progress to its fullest and to compensate as much as possible for budget cuts.

The study should be generic and determine the boundary of the interdisciplinary system and demonstrate the usefulness to answer eminent practical questions. Some questions may be: Can existing dominant military facilities be used in part for the production of commercial products such as those presently imported? Can commercial and military facilities cooperate in the development of new product lines, either competitive or in the world marketplace or as a substitute for imports? Are cost

sharing concepts between military and commercial goods possible, benefiting both? Note all questions have interdisciplinary aspects.

Phase I shall deal with the conceptual problem in order to determine the feasibility of a specific oriented Phase II.

NAVAL SURFACE WARFARE CENTER

N90-362   TITLE: Nonlinear Optical Processing Using Photopolymer Film Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate the application of photopolymer films in optical devices or systems capable of performing real-time nonlinear transformations.

DESCRIPTION: Optical systems provide true parallelism and thus great speed advantages over electronic systems in a large number of signal processing applications. Linear operations such as correlation, convolution and Fourier Transform processing are relatively easy to implement. Many signal processing techniques required to support radar applications require nonlinear transforms such as the logarithm function as part of their operation. New concepts and techniques for nonlinear optical processing are required in order to perform nonlinear transformation with high resolution and high data throughput. Photopolymer films have intrinsic nonlinear optical properties. This suggests that possible development of optical devices and architectures to perform nonlinear transformations which combine high speed with high resolution and do not require costly and cumbersome spatial light modulators or nonlinear crystals.

N90-363   TITLE: Polarization Insensitive Radomes for High Speed Missiles

CATEGORY: Advanced Development

OBJECTIVE: Successful fabrication and demonstration of a polarization insensitive radome suitable for high speed missile applications.

DESCRIPTION: The need exists for a polarization insensitive radome for high performance high speed homing missiles. The radome must maintain structural integrity during launch and flight. It must be of a shape that is compatible with low drag high speed missile applications and the electrical performance must be comparable to current half wave radomes. Cancellation of the boresight errors or slopes is acceptable to achieve the required low boresight errors for guidance. However, the in-flight variation of these errors and corresponding cancellation values must be quantified.

N90-364   TITLE: Signal Processing For Anti-Radiation Missile Receivers

CATEGORY: Exploratory Development

OBJECTIVE: Enhance signal processing in missile receivers or surface systems to increase their sensitivity and direction finding accuracy with minimum hardware modification.

DESCRIPTION: Modern anti-radiation missiles are designed to hunt and attack enemy radar installations, but these missiles must become more sophisticated to overcome the increasingly complex countermeasures used against them. They need to be more sensitive in order to detect back and side lobes of targets, and they must also be able to counter advanced waveforms, low-frequency and multiple or expanded frequency usage by targets. One way of improving receiver performance without impacting hardware is to improve signal processing capability. Modern signal processing techniques, such as morphological procedures, higher order statistics (bispection, trispection) and neural network architectures, can be used to increase detection capability as well as the accuracy of direction finding.

Phase I should produce a conceptual design of a receiver which has its signal processing capabilities optimized for naval anti-radiation missiles and/or surface support systems.

Phase II should produce a prototype receiver which should be evaluated in the laboratory and/or in field tests against expected threat radars.

N90-365   TITLE: High Efficiency Ada Compiler

CATEGORY: Exploratory Development

OBJECTIVE: Study the feasibility and implement a high efficiency Ada compiler to minimize system overhead and memory requirements in small, real time systems.

DESCRIPTION: Present Ada compilers impose a very large overhead, a factor of 3 or 4, in terms of operating speed and memory requirements. Small volume and/or power limited real-time systems such as those used in airborne computers cannot function acceptably with such a high overhead, and cannot presently gain the advantages of Ada.
    Phase I Definition and Deliverables - A study would investigate the feasibility of a high efficiency Ada compiler that would execute with minimal performance degradation and memory requirements, in the range of 16K to 64K bytes for the total system, application and overhead. These requirements are driven by the need to conserve electric power in small systems with self-contained power sources.
    Phase II Definition and Deliverables - A high efficiency Ada compiler would be written and targeted to modern high performance microprocessors such as the Harris RTX2000 Forth engine and/or the Allied Signal 1750A chip. The size of the compiler itself is not critical, but the application program and overhead code must be in the range of 16K to 64K bytes and execute with the absolute minimum of overhead to conserve electrical power. Demonstration of the compiler in an existing airborne computer system, such as the AYK-14, should be included.

NAVAL WEAPONS CENTER

N90-366   TITLE: Amplifying Ferromagnetic Echoing Device

CATEGORY: Exploratory Development

OBJECTIVE: Design (Phase I) and build a bench-test model (Phase II) of an amplifying ferromagnetic echoing device (AFED) to work at 800-900 MHz for certain electronic warfare applications.

DESCRIPTION: An AFED is a circa one-pound device that uses an yttrium-iron-garnet crystal to store a low-power microwave pulse for several microseconds, and then gives out an amplified form of said pulse when triggered by a very narrow recall pulse. AFEDs have been built and successfully bench-tested at higher microwave frequencies than stated in this objective, but experience in these efforts has not explored operation down to 800 MHz. The contractor undertaking this task is expected to incorporate the recall pulse generator in his design.
    The Phase I output is to be a description and sketches depicting the proposed design and the performance expected.
    Phase II is to include a demonstration of performance to Navy personnel and a report including design particulars, photos, and test results.

N90-367   TITLE: Light Emitting Diode/Laser Array for Optical Correlator

CATEGORY: Advanced Development

OBJECTIVE: Design, develop, and fabricate a 256 element linear light emitting diode array (or broad band laser diode array) module for use in high speed hybrid optical correlator systems.

DESCRIPTION: High speed optical correlator architectures which use Acousto-optic devices to perform two dimensional convolutions and correlations by processing standard television formatted video signals require a 256 element array of light emitting diodes capable of being modulated by TV video signals. The correlators are required for high speed processing in implementation of special algorithms for target identification and classification. The spacing of the elements are to be 100 microns apart and aligned linearly in a one dimensional array. The individual array elements must be capable of being modulated with NTSC and RS-170 video format signals with a bandwidth up to 10 MHz. Power output coupled into free space for each element must be in excess of 5 milliwatts. The illumination of each element shall be uniform over a 30 degree solid angle. The desired wavelength is to be centered at 830nm and the spectral bandwidth of at least 50nm. The power output variation between elements shall be no greater than 2db. A rugged, compact, power efficient design is desired with appropriate means for cooling the module. Appropriate driver interface circuitry shall be included in the design as well as provisions for protection against over-voltage or over-current burnout.

N90-368   TITLE: Development of Mobile Surface-clutter Mapper

CATEGORY: Exploratory Development

OBJECTIVE: Develop a mobile system that will allow for surface clutter mapping in two or more frequency bands with dual, linear polarization; 60 to 80db of instantaneous dynamic range; and small volume (AZ, EL, Rn) resolution cell. Develop methodology for absolute cross-section calibration. The system will be utilized for development of color-coded display data to be incorporated into test reports. This system will be utilized to probe and characterize the site environment at any given location.

DESCRIPTION: Development Phase I: (1) Establish detailed requirements for the Fully Mobile Surface-Clutter Mapper hardware and software system, and (2) research hardware and software already available which could be (a) modified to perform this task, or (b) used to partially satisfy the requirements for this task.
          Development Phase II: Conduct a conceptual study and assess availability of off-the-shelf hardware and software. Next, develop a basic design utilizing existing hardware and software technology.
          These two phases would be followed by a Phase III development of a fully functional system to meet the requirements defined in Phase I and the basic design of Phase II.
          Beneficiaries: This system could be utilized by all test ranges and Services who have a need to do in-depth accurate clutter mapping.

N90-369   TITLE: Electromagnetic Wave Analysis of Radomes Shielding Spiral Antennas

CATEGORY: Research

OBJECTIVE: To gain a more complete understanding of the Electromagnetic (EM) scattering associated with aerodynamic radomes protecting broadband spiral antennas providing the guidance signals in air-to-ground and air-to-air missiles. Radome induced errors lead to missile guidance errors which may lead to unacceptable miss distances.

DESCRIPTION: All Air-to-Ground and Air-to-Air missiles such as HARM, Sparrow and Side-Arm must have radomes to protect the delicate guidance antennas. These radomes can not be made perfectly transparent to the electromagnetic signals that must pass through the radomes. For HARM, Side-Arm and other new generation missiles, the radome induced errors limit the choice of materials and construction that may be successfully utilized.
          To improve the performance of the radomes, or to meet new and more demanding threats, it is desirable to optimize radomes by advanced EM scattering analysis and experimental verification of these computer codes. Also these codes would be Government owned - not company proprietary - for general use in DOD by technically qualified researchers and designers.
          Phase I - Computer Code Development
          Phase II - Experimental verification of predicted EM scattering characteristics of a generic radome.

NAVAL AIR DEVELOPMENT CENTER

N90-370   TITLE: Parachute Load Transfer Reduction

CATEGORY: Exploratory Development

OBJECTIVE: This effort will result in the design and development of an energy absorbing system that will reduce and regulate the parachute opening shock load transfer to a crew member during emergency ejection.

DESCRIPTION: Ejection from a stricken aircraft is a hazardous undertaking and as the last line of survival there is always the chance that the crew member will be injured as the sequence of events unfold. The probability of injury by parachute forces increases with the speed and altitude of the aircraft on ejection. At the higher "g's" there is always a time delay period before opening the parachute canopy. Its purpose is to allow the seat to decelerate to a safe velocity before extracting the chute. This is done primarily to keep the canopy structurally intact when it opens and also to reduce the acceleration forces on the crew member to tolerate limits. At the higher altitudes it would be appropriate to let the seat velocity decay to a reasonable speed before opening the chute. However, the selected time delay is a trade-off between the many scenarios under which ejections take place. A long time delay before extracting the chute would be disastrous at low altitudes since precious time will be lost.
          Phase I will research available literature to obtain the accelerative forces and loads produced by the opening of a parachute during a ejection sequence. Based upon known physiological limitations to accelerations in the Gz direction and other

limiting factors such as angular velocity changes, a working range will be established for the design of an Energy Absorbing System also call a Load Limiting Device (LLD). Perform preliminary analysis through modeling to establish system design criteria and performance characteristics. Also, conduct feasibility studies for energy attenuation and its location. The contractor will deliver conceptual designs based upon the literature search.

In Phase II the LLD will be designed and fabricated to either interface with the seat bucket structure or as part of the parachute risers. A testing program will be conducted to obtain performance data in Phase II. An ejection seat frame and a parachute will be provided to the contractor for the purpose of testing.

N90-371   TITLE: Dual Function Optical Scanner

CATEGORY: Advanced Development

OBJECTIVE: To develop passive electro-optical sensor for Air ASW and surveillance

DESCRIPTION: The Navy's infrared imaging equipment provides moderate to high spatial resolution of scenes and targets at low to moderate thermal sensitivity. However, some naval applications such as tactical oceanography and ASW require very high thermal sensitivities. Accordingly, new infrared line scan imaging equipment is needed to provide simultaneously, high spatial resolution of targets and high thermal resolution of the scene. One of the components needed for such a device is a dual function optical system for use in multifunction infrared line scan imaging equipment. Such devices and components are not currently available. This development should proceed in two phases. Phase I is a study with the objective to define and design an optical scanner assembly including the scanner mirror, scanner motor, collecting optics, detector assembly interface and electronics (including sync and position signal generation). This optical scanner assembly shall be capable of collecting infrared radiation simultaneously in both high spatial resolution and high thermal sensitivity modes. Some key characteristics of this optical scanner assembly include (1) F Number - Approximately 2.0, for use with mercury cadmium telluride detectors, (2) Active Scanned Scene Angle -120 degree (60 degree each side of nadir), (3) Reflecting Optics comprising low distortion scanning optics and collecting optics to produce an image on an infrared detector assembly (not part of this SBIR). (4) Rugged construction for airborne military equipment applications.

The Phase I study would conclude with a design for the optical scanner assembly and associated electronics including all required parameters, specification, ray traces and drawings needed to fabricate the device.

Phase II would be the fabrication of the Dual Function Optical System from the design package proposed in Phase I.

N90-372   TITLE: Neural Network Applications to Flight Control

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the possibilities of using neural networks to implement the flight control functions for advanced manned aircraft.

DESCRIPTION: Neural networks have the potential to provide adaptation to changing or uncertain dynamic characteristics of high performance aerospace vehicles, and ever-improving performance through dynamic learning.

The objective of the Phase I effort is to develop and demonstrate (via simulation) a neural network architecture and learning algorithm which will stabilize a representative high performance aircraft exhibiting both static and dynamic instabilities and uncertainties in its plant dynamics. The neural network architecture must also provide acceptable flying qualities in response to pilot inputs through model-reference or other techniques.

Phase II will expand the Phase I results to provide robust control and stabilization features in a distributed neural network having excellent survivability and fault tolerant properties. Potentials for using neural networks for advanced functions such as automated trajectory control, integrated fire/flight control, and battle damage re-configuration will also be explored in Phase II.

N90-373   TITLE: Miniaturized Metallic Glass Accelerometer

CATEGORY: Exploratory Development

OBJECTIVE: Develop, fabricate, and evaluate a prototype, miniaturized accelerometer, utilizing metallic glass as the transduction material.

DESCRIPTION: The new amorphous magnetostrictive metallic glassy materials exhibit almost perfect magnetomechanical coupling. This exceptional coupling factor (k≈ 0.97) can be exploited to achieve a highly sensitive accelerometer, with extended low frequency capabilities in a miniaturized form factor for application in naval underwater systems. Research at two naval laboratories has proven feasibility of a novel bi-directional metallic glass accelerometer; both a theoretical model, capable of predicting performance, and a breadboard sensor, demonstrating the expected performance, have been developed. Further development of this accelerometer is sought, leading to an inexpensive, small, but robust, commercial sensor.
        Phase I goals are to review and assimilate the metallic glass sensor development to date, and to successfully design, fabricate, and evaluate a single-channel accelerometer with extended low frequency capability.
        Phase II goal will be to develop an optimized bi-directional accelerometer design to meet specific navy performance requirements. This effort is expected to entail an iterative process, consisting of design, fabrication, and evaluation/analysis, ultimately leading to a refined prototype accelerometer sensor, capable of being mass-produced.

PACIFIC MISSILE TEST CENTER

N90-374   TITLE: Electronic Optical Vector Scoring System

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop an accurate and reliable vector scoring system for end game analysis.

DESCRIPTION: Test and evaluation ranges need a system for accurately measuring the trajectory of a missile, relative to a target during the final phase of a missile's attack on a target. Current systems are unreliable, difficult to apply, or too expensive. A new approach is needed for solving this problem. State-of-the-art electronic optical detection elements will be developed which will be integrated witn solid-state array detector/read electronics, high speed pixel sampling data compression with motion detection and filtering of the pixel output. The electronic optical vector scoring system (EOVSS) shall be designed for use on the target vehicle which is usually an aircraft converted to a drone target or special sub-scale aircraft built specifically for drone target usage.
        The EOVSS should be able to accurately measure and provide a three dimensional output of the position of the missile relative to the target to accuracy's approaching a fraction of an inch. If the missile deploys several smaller missiles/objects during the final approach the EOVSS should provide position output for each of those. The position outpu should be provided regardless of which direction the missile approached the target. Ideally, there should be no modifications to the missile needed to support the EOVSS, however, minor changes such as special coatings should be considered.
        Phase I. Develop the detailed block diagram and signal flow diagram for the system. Determine each area/concept involving moderate to high technological risk. Characterize the nature of each risk and what alterative may be available for mediating the problem. Develop the theoretical limits of the system performance.
        Phase II should develop prototype hardware and software to be used for test and evaluation.

NAVAL TRAINING SYSTEMS CENTER

N90-375   TITLE: Texture Modeling Techniques for Simulation of Infrared Sensor Displays for Mission Practice in Night/Low Visibility Conditions

CATEGORY: Exploratory Development

OBJECTIVE: Develop computer image generation (CIG) texture models to assist programmers during development of real-time infrared (IR) displays to be used for mission practice under night/low visibility conditions. Use of texture can increase realism and reduce programming costs associated with development of CIG IR data bases used in simulation weapon system trainers IR avionics and/or other part task avionics simulators.

DESCRIPTION: The use of CIG texture techniques can enhance realism and reduce program development time required to produce data bases for (IR) sensor displays. Current IR simulation methods use physical models to compute the temperature of geometrically simulated 3D objects and terrain in an off-line, non-real-time mode in order to predict the shade/intensity of surfaces appearing in real-time IR displays. The use of texture patterns to fill displayed polygons in the real-time mode can reduce programming complexity while increasing visual complexity of displayed terrain. Reductions in program complexity translate directly into reduced programming and development cost for CIG data base development.

This task should investigate use of texture patterns in simulation of IR imagery for various types of terrain using current computer graphics workstation technology in non-real-time during Phase I and develop a proposal providing extensions to allow real-time simulation for Phase II.

NAVAL AIR PROPULSION CENTER

N90-376   TITLE: Unmanned Aerial Vehicle (UAV) Propeller Load Control

CATEGORY: Exploratory Development

OBJECTIVE: To provide increased efficiency propulsors for use in block upgrades of the short range UAV and full scale development of the endurance UAV.

DESCRIPTION: The DOD Joint UAV program requires technology which will improve the performance of systems being developed to fulfill the categories of short range and endurance UAV's. This technology should concentrate on improving propulsive efficiencies at applicable flight conditions, thus, resulting in improved system performance. Innovative methods of propeller load control other than conventional mechanical pitch control are desired.
        It is desired that the system be lightweight, self-contained and autonomous. Flight test hardware for a 50 HP engine is required in Phase II.

N90-377   TITLE: Unmanned Air Vehicle (UAV) Propeller Erosion Protection

CATEGORY: Exploratory Development

OBJECTIVE: To provide low cost propellers for use on UAV's which will improve the capability of close, short range and endurance UAV systems.

DESCRIPTION: Current operational systems and anticipated future systems use wood or composite propeller blades. These materials have very poor erosion resistance in rain, dust and other erosive environments. Low cost and durable systems of erosion protection is desired for small wood and composite propellers.
        It is desired that in Phase I, two 29 inch wood propellers would be treated with the erosion protection system. These propellers will be evaluated on the pioneer UAV system.
        Phase II would develop low cost, high rate production techniques.

N90-378   TITLE: Innovative Small Engine Concepts

CATEGORY: Exploratory Development

OBJECTIVE: To look at breakthrough, state-of-the-art, innovative engine concepts to determine feasibility of concept.

DESCRIPTION: The DOD desires to continue looking for advanced innovative small engine concepts that will advance the present state-of-the-art with applications including remotely piloted vehicles and portable fire pumps. Innovative concepts and design should focus around diesel fuel operation and lightweight construction. It is anticipated that investigation into candidate innovative concepts would be divided into two phases. First, conceptual designs would be generated and validated through theory and analytical assessment and/or testing. Second, based on successful results of the first phase, fabrication of proof of concept designs and experimental verification of the approach would be made.

N90-379   TITLE: Lightweight Remotely Piloted Vehicle Engine Alternator/Starter

CATEGORY: Exploratory Development

OBJECTIVE: To provide a very lightweight alternator/starter component weighing much less than 12 lbs. with an output of 3 KW and 28 volts at 4000 RPM or less.

DESCRIPTION: The DOD Joint Unmanned Aerial Vehicle project office desires to field remotely piloted vehicle (RPV) engines for close, short and endurance categories which are highly reliable, provide increased utility and are cost effective. This situation has placed greater emphasis on achieving lightweight engine components capable of handling longer endurance, greater payload capacity and higher reliability. To achieve these more efficient, cost effective systems, it is necessary to exploit various technology areas and extend the state-of-the-art. New and innovative approaches are sought to enhance the alternator/starter subsystem of the RPV engines. The program objective is to design and develop a lightweight alternator/starter component with an output of 3.0 KW at 28.0 volts when operating at 4000 RPM and weighing significantly less than 12 lbs.

It is anticipated that investigation into candidate alternator/starter subsystems would be divided into two phases. First, conceptual designs would be generated and validated through theory and analytical assessment and/or testing. Second, based on successful results of the first phase, fabrication of proof of concept designs and experimental verification of the approach would be made.

N90-380   TITLE: Fuel/Icing Inhibitor Recovery Using Crossflow Membrane Separator

CATEGORY: Exploratory Development

OBJECTIVE: Determine applicability of crossflow membrane separator system to fuel/icing inhibitor additive recovery in ship's JP-5 reclamation system.

DESCRIPTION: Previous testing has shown crossflow membrane separation technology to be efficient at fuel, water and dirt separations. Alternate fiber membrane modules may have capability to recover hydrocarbons (fuel) in tank/filter bottoms and/or recover fuel system icing inhibitor additive for eventual reblending.

Phase I: Determine appropriate fiber membrane for additive separation, demonstrate separation capabilities in laboratory scale prototype.

Phase II: Develop bench-scale prototype fuel/additive reclamation blending system.

N90-381   TITLE: High Energy Density, Long Life Secondary Battery Research and Development

CATEGORY: Advanced Research

OBJECTIVE: To obtain research and development in advancing state-of-the-art secondary battery technology.

DESCRIPTION: The Navy desires high energy density, long operating capacity secondary (rechargeable) battery research and development for use in powering 25-50 HP electric motors. These motors and batteries would be used together with a propeller to power unmanned air vehicles systems. The effort should include an assessment of the current "state-of-the-art" in high density/long life secondary battery characteristics. The program goal is to obtain a secondary battery with an energy density of 600 WH/Kg, or twice that of lithium batteries. Current lithium batteries have an energy density of 300 WH/Kg.

NAVAL OCEAN SYSTEMS CENTER

N90-382   TITLE: Air Traffic Control by 3D Volumetric Display System

CATEGORY: Exploratory Development

OBJECTIVE: The object is to develop multiplanar 3D display system that uses a modulated laser beam which is synchronized with a moving display surface (helix) to address any point in the volume. This display system is to provide true 3D images which would be viewed for air traffic control from any angle.

DESCRIPTION: 3D displays truly offer a port for avionics to communicate a spatial awareness to air traffic controller, or the pilot in all directions. The 3D display approach allows a total spherical world to be generated so that information is conveyed in spatially relevant directions.

Volumetric (multiplanar) displays use X, Y, Z addressable display volume by physically creating multiple planes. They have the advantage that they require neither binocular or sequential presentation, nor the fusing of virtual images. They simply create a volume which is used as a display surface. The ideal volumetric 3D display system would be viewable from all angles, with naked eyes, simultaneously by several viewers.

Potential applications are characterized by the need to view real 3D objects in a volume. The users could view the objects from various angles to evaluate the real time 3D position of multiple objects. The most obvious near term applications are: cockpit and crew station display, air traffic control, battle management, weather pattern analysis, medical 3D imaging molecular modeling and remote manipulation.

The display system consists of random scan laser beam which is modulated by acousto-optic (AO) modulators and is synchronized with the Z dimension displacement of the rotating helix. The beam is scanned in X and Y, while the synchronization of the modulation with the rotating helix provides the Z dimension. The helix is translucent providing for the optimum persistence of the 3D image which is fused by the observer's eyes.

The display can be theoretically as large as the application requires with as many laser sources as is needed to generate the necessary display elements in real time. The display volumetric can be enlarged by simply increasing the diameter of the helix to meet the application requirements.

N90-383   TITLE: Integrated Planar Magnetics For High Density Power Supplies

CATEGORY: Advanced Development

OBJECTIVE: To explore the technical feasibility of improved performance of magnetic devices for megahertz operation in high power density (100 watts/cm^3) power supplies using planar integrated construction. Primary objectives are planar construction, improved power efficiency, higher energy density, and low cost. A baseline for improvement is 2 MHz frequency, transformer power rating of 100 watts @ >99% efficiency voltage ratio 50-100v (primary) to 5v-3.3v-1.5v (secondary), with a volume not to exceed one tenth cubic inch. Inductor baseline is 300 volt-amperes @ 2 MHz, with a power factor not to exceed 0.003 and a volume not to exceed one tenth cubic inch using a profile (height divided by [length times width]) no more than 0.030.

DESCRIPTION: Design/construction of low voltage electronic power supplies must be simplified. The Navy/Air Force are presently contracting for the development of higher efficiency and power density power supplies to provide reliable power to very high speed, high density integrated circuit systems. This is necessary due to the excessive size factor which results with the use of the best available commercial low voltage power supplies. Presently available power supplies would exceed the volume of the remainder of the systems; the rule of thumb is for the power supply's volume not to exceed 25% of the volume of the system.

A major problem in power supply packaging and circuit assembly is the presently design-mandated shapes of the magnetic components, i.e. near cubical in shape. Magnetic devices do not lend themselves to easily conform to high density solid planar structures, rather they are commonly built as separate coil/cord structures which, when assembled, are spacewise inefficient and will not easily conform to the printed circuit layout used for the integrated circuits of the system. This nonconformity dictates greater printed circuit card spacing when the power supply is included on the printed circuit card, or requires that the power supply be remotely placed. The remote placement of the power supply aggravates the system volume by the extended low voltage lines and connector interface serial impedances. Additional decoupling and impedance lowering capacitors must be used for operational reliability. Either card spacing must be increased or added components are required in the conventional approaches outlined above. Therefore, low profile, high performance magnetic components are highly valued. Projected use is in the power management for Avionics, E.W. and JIAWG.

Phase I: Explore the technical feasibility of low profile, highly efficient magnetic devices outlined in the objective. Fabricate and evaluate samples satisfying the above specifications of voltage, power and loss (efficiency) and their characteristics as well as the design principles.

Phase II: Explore low cost production of high reliability components and run a pilot production proving the concept.

N90-384   TITLE: LSI (Large System Integrated) Neural Networks For Associative Memory Arrays

CATEGORY: Advanced Development

OBJECTIVE: Investigate relevant neural network architectures for associative memory arrays, compatible with silicon VLSI circuitry, and demonstrate prototype neural analog memory/computing system.

DESCRIPTION: State-of-the-art digital computing (e.g., RISC architecture) and optical analog signal processing (e.g., Bragg Cells for EW IF channelizers) systems are limited in bandwidth, reliability, material reproducibility and device performance. A resurgence in the field of Artificial Neural Networks (ANNs) which seeks to emulate the biological information processing methods of the brain offers great promise for increasing the information processing capabilities of present technologies. The capabilities are mainly due to the fact that many ANN models are adaptive in nature; that is, they "learn" much like real

organisms. Beyond the robotic and telerobotic control, knowledge processing and other AI functions, ANNs offer promise as highly efficient analog computers to the solution of previously intractable problems in sensor interception, as encountered in pattern recognition; image (target) matching; associative computer memory and control; radar and sonar signal processing and preprocessing. ANNs are presently in a phase of hardware implementation to achieve the potential of compactness, speed and parallelism for real time applications.

Phase I (six month duration) will address:

a. Material, devices and architecture of an associative memory array based on ANNs to ultimately achieve 10^{11} and 10^{12} interconnects/sec for application to "matching" (audio, video) problems using multidimensional inputs.

b. Modeling of a storage cell for the ARAM array to be developed; extraction of access time, retention time and dynamic range/error characteristics will be investigated.

Phase II of the effort will explore the practical implementation of the design, followed by a technology demonstration illustrating the several orders of magnitude improvement offered by the physical use of VLSI associative memory arrays based on ANNs. The study of limiting factors affecting the operation of the ARAM array will be carried out; particularly, the following properties will be characterized:

1 - Offset errors
2 - Noise
3 - Linearity
4 - Dynamic range
5 - Frequency response
6 - Power dissipation
7 - Susceptibility to parasitic oscillations
8 - Modularity

NAVAL AIR TEST CENTER

N90-385   TITLE: Helicopter Simulator Rotor Disk and Blade Element Comparison

CATEGORY: Exploratory Development

OBJECTIVE: Define and analytically demonstrate the differences between helicopter main and tail rotor disk and blade element models in terms of simulator flight fidelity and computation requirements and associated costs. Resultant models will have applicability to helicopter simulators.

DESCRIPTION: Early helicopter Operational Flight Trainers (OFT) and Weapon System Trainers (WST) often used simplified rotor disk models. Increases in computational capability and the desire to improve the helicopter simulator flight fidelity has spurred on development of detailed rotor system blade element models. Tradeoffs exist between increased flight fidelity and associated increased flight simulation program cost.

Phase I requires the investigation of cost tradeoffs between using rotor disks or blade element models in OFT and WST development. It also requires addressing the effect of the rotor model on each element in the simulator flight fidelity test program, analytically defining advantages and disadvantages of each approach. Primary emphasis will be placed on single main rotor, single tail rotor helicopters, with discussions of tandem rotor and tilt rotor type rotorcraft.

Phase II will require development of a generic real-time blade element model with modular structure and standard format for module inputs and outputs; and verification and validation of the model for a specified helicopter, and demonstration tests on a selected Navy simulator. Also determination of the model input data requirements to represent single rotor (articulated and teetering) and tandem helicopters plus tilt-rotor rotorcraft will be required.

N90-386   TITLE: Deep Water Pinger Locator System

CATEGORY: Engineering Development

OBJECTIVE: A system for locating International Distress Pingers mounted on flight data recorders and high value test and evaluation end items such as missiles, drones, and manned tactical aircraft that are in deep water. A market for this system exists among all government and civilian agencies that need to recover flight data recorders and military hardware.

DESCRIPTION: International distress frequency underwater locator beacons (pingers) are installed in flight data recorders and in high value type equipment used in military testing and training worldwide. The current method for locating pingers is manual and is limited by locator system slant range (typically 1 to 2 nautical miles). This limited range has precluded recovery of the flight

data recorders of recent probable terrorist bombings over ocean depths which exceed the locator system range. New technological developments may enable improved capability through increased slant range or through an automated search capability. Two approaches must be researched: 1) increase the path budget by increasing either receiver sensitivity or pinger transmit power, or both; 2) placing the locator sensor closer to the pinger by using sonobuoys with extended sensor depth and frequency range or developing an automatic-piloted "swimmer" which executes a pre-programmed search path and signals when the pinger is located.

Phase I requires examination of the trade-offs between each approach, including simulations and cost estimates, to develop and deploy hardware and the specification of the system.

Phase II will require production of a fully documented prototype system and demonstration tests at the Naval Air Test Center.

N90-387   TITLE: Dynamic Laser Threat Illumination System

CATEGORY: Engineering Development

OBJECTIVE: A system which can illuminate an aircraft with laser energy equivalent to a threat laser in a hangar environment. This system would have applicability for all types of military aircraft, vehicles, tanks, etc. that require laser warning systems.

DESCRIPTION: Recognizing the increased use of battle field lasers and the dangers involved in flight test of laser warning receivers, testing requiring illuminating the aircraft with dangerous levels of laser energy will be done with an unmanned aircraft in an enclosed hangar. An illumination system is needed which will incorporate, but not be limited to, the following wavelengths: 0.514, 0.532, 0.904, 1.06 and 10.6 micrometers. The system will have continuously variable output power, pulse width, pulse code, direction of arrival and beam divergence. The laser parameters will be under computer control, with the capability to pre-program, store and replay a sequence of events. The system must be mobile and modular.

Phase I requires the development and specification of the system.

Phase II will require producing a prototype system for test at the Naval Air Test Center.

N90-388   TITLE: Wide-band Imaging Spectroradiometer System

CATEGORY: Engineering Development

OBJECTIVE: An imaging system to measure the spectral contribution of infrared (IR) targets and projection devices in a variety of discrete spectral bands. A market exists for this system in Government and industry wherever dynamic IR testing is performed.

DESCRIPTION: Current spectroradiometer systems are non-imaging and require changing filters to achieve discrete spectral band measurements. The spectral characteristic of an object can vary over its surface and change over time. An imaging spectroradiometer which could image multiple wavelengths simultaneously or near simultaneously, and measure the IR radiance, would provide superior data for analyzing dynamic events. The system should incorporate computerized image analysis and be transportable with minimum support required for operation.

Phase I requires the design and specification of the system.

Phase II will require the production of a prototype and demonstrations tests at the Naval Air Test Center.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR Program rests with the Program Management Office. The DARPA Coordinator for SBIR is Dr. Bud Durand. DARPA invites the small business community to send proposals directly to DARPA at the following address:

> DARPA/PM/SBIR
> Attention: Dr. Bud Durand
> 1400 Wilson Boulevard
> Arlington, VA 22209-2308

The proposals will be processed in the Program Management Office and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 70 technical topics, numbered DARPA90-062 through DARPA90-131, to which small business may respond in this the second fiscal year (FY) 1990 solicitation (90.2). Please note that these are the only topics for which proposals will be accepted at this time. The previously advertised solicitation for FY 1990 (Solicitation 90.1) which identified 61 technical topics for DARPA, opened on 1 October 1989 and closed on 5 January 1990. Proposals can no longer be accepted on those previously advertised 61 technical topics which were numbered DARPA90-001 through DARPA90-061. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. The topics originated from DARPA technical offices.

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military applicability as the budget and other factors will allow. In the early years of the SBIR program most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. DARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II limit has been lowered to $250,000.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposals in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and can only respond to one topic.

DARPA has prepared a checklist to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or handcarrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DARPA 1990 Phase I SBIR

Check List

1) Proposal Format

    a. Cover Sheet - Apendix A (identify topic number)   ____
    b. Project Summary - Appendix B   ____
    c. Identification and Significance of Problem or Opportunity   ____
    d. Phase I Technical Objectives   ____
    e. Phase I Work Plan   ____
    f. Related Work   ____
    g. Relationship with Future Research and Development   ____
    h. Post Potential Applications   ____
    i. Key Personnel   ____
    j. Facilities/Equipment   ____
    k. Consultants   ____
    l. Prior, Cu⁻ ⁻t or Pending Support   ____
    m. Cost Proposal   ____

2) Bindings

    a. Staple proposals in upper left hand corner.   ____
    b. Do not use a cover.   ____
    c. Do not use special bindings.   ____

3) Page Limitation

    a. Total for each proposal 25 pages inclusive of cost proposal
        (Appendix C) and resumes.   ____
    b. Beyond the 25 page limit do not send appendices, attachments
        and/or additional references.   ____

4) Submission Requirement

    a. For DARPA you must submit 4 copies plus the original signature
        copy (total 5) for each proposal to be considered.   ____
    b. In addition you must submit two copies of Appendix A and
        Appendix B only, for each proposal submission.   ____

5) Proposal Acknowledgement

    a. Include Reference B.   ____
    b. Include Self Addressed, Stamped, Envelope.   ____

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
FY 1990 Small Business Innovation Research Topics

DARPA 90-062	On-site Inspection Procedures and Techniques for Detection of Underground, Large, Hidden Cavities in Field, Mining, or Other Environments
DARPA 90-063	Techniques for In-situ Borehold Determination of Gas-filled Porosity to Better Than 1% at 200-1000 Meter Depths
DARPA 90-064	Techniques for In-situ Dynamic Stress Measurements in Rocks in the 10-300 KBar Range
DARPA 90-065	Seismic Network Concepts for Location of Targets and Events
DARPA 90-066	Development of a Substitute for (Highly Toxic) Arsine Gas for Use in Fabrication of Gallium Arsenide Material
DARPA 90-067	Advanced Microwave and Millimeter Wave Devices and Circuits
DARPA 90-068	Innovative Packaging Techniques and Package Models
DARPA 90-069	Development of Computer Aided Design and Process Models for Microwave and Millimeter Wave Devices and Circuits
DARPA 90-070	Computer Analysis of New Microwave Devices and/or Monolithic Circuit Techniques
DARPA 90-071	Mask Materials (Membranes/Absorbers) for X-ray Lithography
DARPA 90-072	High Brightness X-ray Sources for X-ray Lithography
DARPA 90-073	Photoresists for Optical Lithography at Wavelengths of 250 nm or Less
DARPA 90-074	Fabrication of Micro-optical Components
DARPA 90-075	Fabrication Techniques Related to Monolithic Photonic Transmit/Receive Modules
DARPA 90-076	Fabrication/Materials for Assembly of Laser Diode Arrays
DARPA 90-077	In-situ Process Monitoring for Metal Organic Chemical Vapor Deposition Material Growth
DARPA 90-078	Graphical Displays for Manufacturing Process Simulation
DARPA 90-079	Simulation and Modeling to Predict Life Cycle Product Costs
DARPA 90-080	Inexpensive Gigabit Local Area Network Technology

DARPA 90-081	Terabit-per-second Local Area Network Technology
DARPA 90-082	Speech Recognition Modules
DARPA 90-083	Acoustic Preprocessor for Speech
DARPA 90-084	Interface Standards for Simulation Systems (i.e. SIMNET to BBS to JESS)
DARPA 90-085	High Definition Video Technology Based Head Mounted Displays for Visualization of Real-time Systems
DARPA 90-086	Low Cost Portable Computer Generation Image Machines
DARPA 90-087	Low Cost Reconfigurable Generic Computer Workstations for Simulation Research/Development/Analysis
DARPA 90-088	Virtual World Interactions Using Heads-on Displays and Magic Glove Interaction
DARPA 90-089	Low Power Complementary Metal Oxide Semiconductor Design Tools
DARPA 90-090	High Performance Flexible Interconnect Technology
DARPA 90-091	Small Scale, Special Purpose Hardware Accelerators
DARPA 90-092	Rapid Prototyping Techniques and Methodologies
DARPA 90-093	System Level Packaging Design Tools and Interfaces
DARPA 90-094	Technology Independent, Performance Driven Design Tools
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DARPA 90-097	Case-based Reasoning Modules
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DARPA 90-101	A Requirements Language for Tracking Autopilot Systems
DARPA 90-102	Feature-based Design Methods for Predictive Design Paradigms
DARPA 90-103	Integration of Expert System for Process Planning and Feature-based Designs
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DARPA 90-106	Detection of Chemical Agents by Directed Energy
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DARPA 90-124	Artificial Neural Network Target Recognition Demonstration
DARPA 90-125	Dynamic Object Extraction Preprocessor Algorithm for Automatic Target Recognition
DARPA 90-126	Wide Dynamic Range Laser Diodes for Communications

DARPA 90-127	Generators (Electromechanical Power Supplies) for *Miniature Reciprocating Engines (Model Aircraft Size)* with Sustained Power Levels From 1 Watt to 1 Kw
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DARPA 90-062   TITLE: On-site Inspection Procedures and Techniques for Detection of Underground, Large, Hidden Cavities in Field, Mining, or Other Environments

CATEGORY: Engineering Development

OBJECTIVE: To develop and test operational on-site field procedures and equipment to detect cavities suitable for nuclear decoupling near quarries, open mines, and drill-sites.

DESCRIPTION: There is substantial research on tunnel detection and on mineral exploration that is relevant to this subject. In addition, mining engineers and quarry operators may be able to suggest practical clues or means, accounting or physical, of detecting or preventing secret activity. Cavities of interest would range from radii of 10 to 50 meters at depths or at distances from tunnels of up to 1000 meters.

Phase I: Survey the existing literature and experts on this subject. Consult with mining and quarry engineers and operators. Outline suitable procedures and systems and define their probable capabilities. Propose suitable experiments for Phase II.

Phase II: Execute experiments in detecting hidden cavities. Evaluate results and propose designs for operational procedures and systems.

DARPA 90-063   TITLE: Techniques for In-situ Borehold Determination of Gas-filled Porosity to Better Than 1% at 200-1000 Meter Depths

CATEGORY: Engineering Development

OBJECTIVE: To develop an in-situ method for obtaining dry porosity in hard rocks at a depth of 200-1000 meters below the water table and in other rock environments.

DESCRIPTION: Air filled porosity (AFP) reduces the seismic magnitude resulting from underground nuclear tests. The accuracy of current logging methods at the Nevada Test Site for determination of AFP is +/- 5% absolute; that is, if the true porosity is 1% the estimate may be in the range -4% to +6%. What is desired is an operational in-situ technique for determining dry porosity to an accuracy of 1%. If necessary, efficient methods requiring core recovery may be considered. Estimation of AFP below the water table is an important sub-problem.

Phase I: Review existing procedures of determining AFP, both in-situ and in the laboratory. Critically assess the accuracy of the methods, if possible by direct comparison of logging data with the highest quality laboratory data. Plan experiments for Phase II to test improved methods. If possible, execute a few prototype proof-of-principle experiments.

Phase II: Execute experiments designed in Phase I. Implement controls so that absolute accuracy can be definitively evaluated. Use of existing wells, and possible selected existing data, to minimize costs is encouraged.

DARPA 90-064   TITLE: Techniques for In-situ Dynamic Stress Measurements in Rocks in the 10-300 KBar Range

CATEGORY: Engineering Development

OBJECTIVE: To develop new in-situ methods for obtaining dynamic stress measurements within 2-4 cavity radii of a nuclear explosion.

DESCRIPTION: In-situ stress measurements within 2-4 cavity radii of a nuclear explosion can be of use in determining the yield of underground tests for which the original test layout is not spherically symmetrical. Existing instruments for making these measurements use the change of resistivity of selected materials as a function of stress and strain. Ease of emplacement and long-time recording capability are current areas of deficiency.

Phase I: Review existing procedures for estimating dynamic stress. Propose one or more new instrumentation designs. Discuss the advantages of the new designs. Build a prototype instrument. Design and estimate costs for suitable experiments to test the system. In estimating experimental costs, be sure to separately estimate costs of drilling since it is possible that these would be government furnished.

Phase II: Execute and evaluate experiments designed in Phase I.

DARPA 90-065   TITLE: Seismic Network Concepts for Location of Targets and Events

CATEGORY: Engineering Development

OBJECTIVE: To design and test, on synthetic data, a prototype data acquisition and analysis system for battlefield seismic data.

DESCRIPTION: Seismic data from an active battlefield will be multi-source transient, multi-phase (i.e., P, S, LR), and broadband in frequency. It is stipulated that only a human analyst could usefully interact with such data, and then only if it were presented to the analyst on a map base and under his/her command, using intuitive controls similar to those found in video games. Such controls could, e.g., scroll in time, window in frequency and phase velocity, and display at points on the map the product of two array signal amplitudes from those points, with and without forms of automatic gain control.

   Phase I: Assemble and test the software required to generate synthetic seismic (and acoustic) data characteristic of a multi-source battlefield as recorded at two arrays. Discuss the generation of realistic synthetic data using this software. Produce a functional design of the hardware and software required to enable an analyst to usefully interact with such data. Specify the computer hardware and software methods required for a system which will respond fluidly to analyst commands.

   Phase II: Generate realistic synthetic seismograms for two arrays characteristic of a multi-source battlefield. Program an interactive system to enable an analyst to usefully interact with this data. Train an analyst to use the system and to successfully determine the locations and other characteristics of sources on the synthetic battlefield by gradually developing skills as targets progress from simple to complex. Adjust the system characteristics, including network and array design, in response to remarks from the analyst. Discuss the step of applying this system to real data. Discuss application to acoustic data.

DARPA 90-066   TITLE: Development of a Substitute for (Highly Toxic) Arsine Gas for Use in Fabrication of Gallium Arsenide
             Material

CATEGORY: Advanced Development

OBJECTIVE: To develop alternatives to arsine which will be readily accepted by existing and future industries using metalorganic chemical vapor deposition (MOCVD) and a gas-source molecular beam epitaxy (MBE) growth system.

DESCRIPTION: MOCVD and MBE are accepted techniques for the growth of epitaxial layers. In particular, use of MOCVD of III-V semiconductor devices has been most successful, and several production facilities are in operation. These include the production of microwave and millimeter wave integrated circuits, laser diodes of compact disc players, photocathodes for night vision goggles, and gallium arsenide (GaAs) solar cells. The principal weakness of current MOCVD methods is reliance on arsine as a Group V source. Arsine is highly toxic and requires the installation of major facilities with expensive monitoring and safety equipment. Even though the technology for handling arsine is well developed, accidental release of a large quantity of arsine remains possible. Such a catastrophic failure could trigger the temporary or permanent shut-down of all facilities using arsine and interrupt the supply of devices that are critical for defense needs.

   Phase I: Determine optimum conditions and parameters for growth of GaAs MOCVD using alternate sources. Study range of acceptable V/III ratios and compare with those presently used for MOCVD material growth. Develop simple test device structure(s) and compare results achieved using alternate sources with those obtained using standard MOCVD sources.

   Phase II: Continue device development effort with a concentration on more complex device structures. Demonstrate device capabilities achieved using arsine replacement sources. Develop a prototype growth system utilizing alternative environmentally safe sources as a replacement for arsine gas. Demonstrate prototype alternative source growth system capabilities including the potential for scale-up to large diameter (4 inch) substrates.

DARPA 90-067   TITLE: Advanced Microwave and Millimeter Wave Devices and Circuits

CATEGORY: Advanced Development

OBJECTIVE: To advance the development and fabrication of microwave and millimeter wave devices and monolithic format circuits that will provide performance characteristics not presently available, thus satisfying system requirements that are not adequately met.

DESCRIPTION: Gallium arsenide metal-semiconductor field effect transistors (GaAs MESFETs) are being successfully used in a wide range of microwave applications and many millimeter wave applications. However, these devices and the circuits built using them have performance limitations in terms of noise figure, power output and efficiency, particularly at frequencies above 50 GHz. This project is directed toward the development of devices and monolithic format circuits from other material combinations (i.e., heterostructures, indium phosphide) that provide performance improvements compared to the present state-of-the-art. Particular emphasis should be placed on developing devices and circuits to meet military system requirements that cannot adequately be met with existing structures.

   Phase I: Select one or more devices and/or monolithic format circuits that offer the possibility of performance improvements

at microwave and millimeter wave frequencies beyond the present state-of-the-art. Develop a plan for the fabrication of the device and/or circuit structures. Consider approaches that will result in the desired structures being produced at the lowest possible cost.

Phase II: Develop final design and fabricate prototype samples of the device and circuit selected for demonstration. Measure and report upon the DC and microwave (or millimeter wave) frequency performance characteristics.

DARPA 90-068   TITLE: Innovative Packaging Techniques and Package Models

CATEGORY: Advanced Development

OBJECTIVE: To advance the development and fabrication of packaging structures to digital and analog (microwave and millimeter wave) circuits that result in improved performance characteristics, packing densities and lower cost.

DESCRIPTION: Advanced multi-chip packaging structures and packaging boards containing a number of interconnected (digital) chips (chip-on-board) offer the promise of providing improved overall system performance at a lower cost than is possible with each chip individually packaged in a conventional structure.

Packaging structures for millimeter wave frequency analog devices are at an embryonic stage of development. New materials and techniques should allow improved performance characteristics at a lower unit cost than is presently available.

Phase I: Select one or more packaging approaches for either digital circuits, millimeter wave frequency circuits or both. Develop one or more approaches for packaging these circuits in a manner that leads to improved overall performance at the lowest possible costs. Describe performance/cost tradeoffs for each approach studied.

Phase II: Develop final designs and fabricate prototype samples of the package structures selected for demonstration. Measure and report upon their performance characteristics. Develop a plan including a description of the necessary equipment and facilities for producing these packages in large quantities.

DARPA 90-069   TITLE: Development of Computer Aided Design and Process Models for Microwave and Millimeter Wave
                        Devices and Circuits

CATEGORY: Advanced Development

OBJECTIVE: First, to provide models for microwave and millimeter wave frequency solid-state devices and monolithic format circuits that accurately predict actual device and circuit performance over the widest possible frequency range. Emphasis should be placed upon the development of models that predict device/circuit performance from processing parameters. Second, to interface these models with commercially available computer aided design software packages and workstations.

DESCRIPTION: At the present time, reasonably accurate models are available for microwave solid-state devices and circuits that operate in a linear mode within the frequency range from 1 to 20 GHz. Additional work is needed to improve the accuracy of models for operation of devices and circuits in the 20 to 100 GHz range and for operation of active devices in a non-linear (high power) mode. Devices of particular interest are metal-semiconductor field effect transistors (MESFETs), high electron mobility transistors (HEMTs) and heterojunction bipolar transistors (HBTs) fabricated from III-V compound semiconductor materials. Circuits of particular interest are in a monolithic format fabricated from gallium arsenide. Most desirable are models which can be used to tie processing parameters to circuit design parameters.

Phase I: Select one or more devices and/or circuit configurations and develop models which result in accurate prediction of device and/or circuit performance. Provide a clear indication of accuracy and needed improvements. Consideration should be given to how models proposed will extend computer aided design capabilities beyond those afforded by use of currently existing models and to compatibility of models with existing commercially supported software packages and workstations.

Phase II: Complete model development and write appropriate software description that can be used in conjunction with commercially supported software and workstations.

DARPA 90-070   TITLE: Computer Analysis of New Microwave Devices and/or Monolithic Circuit Techniques

CATEGORY: Advanced Development

OBJECTIVE: To provide computer aided design methods to accurately analyze the predicted performance of new analog device and/or monolithic format circuit structures intended for operation in the 1 to 100 GHz frequency range.

DESCRIPTION: A number of recent device structures have been proposed which may result in superior transmitter and/or receiver performance at microwave and millimeter wave frequencies. In some cases, the basic device structure is not new but the material structure proposed for device fabrication is; in other cases, completely new device structures are under consideration. Similarly, new

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circuit designs are under consideration that result in performance advantages such as broader-band operation, higher efficiency operation or higher power outputs. These projects will result in the development of computer aided design techniques and models that can be used to analyze the performance and advantages to be gained from incorporation of new devices and monolithic format circuits in microwave and millimeter wave systems.

Phase I: From technical discussions and literature searches, select one or more promising microwave and/or millimeter wave device and/or monolithic format circuit structures for model development. Provide a proposed model with a clear indication of accuracy and needed improvements.

Phase II: Complete modeling and computer aided design software with emphasis upon accuracy and compatibility with existing commercially available computer aided design software and workstations.

DARPA 90-071   TITLE: Mask Materials (Membranes/Absorbers) for X-ray Lithography

CATEGORY: Advanced Development

OBJECTIVE: To develop membrane/absorber combinations compatible with high resolution definition with high structural stability.

DESCRIPTION: X-ray lithography will be used in the future to make semiconductor devices having features of 0.25 micrometers and below. The patterns are defined by proximity printing with x-rays of about one nanometer wavelength. Currently, the mask is made by patterning a thin film of high atomic number, such as gold, onto a thin membrane, such as silicon, and then bonding it to a quartz ring for handling purposes. Structural stability is required because of the extremely critical dimensions in advanced integrated circuits. Distortion, from stress and thermal effects, must be minimized. The materials should be compatible with the processing required to define the small features in the absorber layer. The thin membrane must support a pattern area of > 2 cm x 2 cm. Optical transparency of > 50% for the membrane is desired. Candidate membrane materials include silicon carbide and diamond; candidate absorber materials include tungsten and tantalum. The totality of mask fabrication will involve a sequence of discrete fabrication steps; any subset that fits reasonably well into an integrated plan will be considered.

Phase I: Select candidate materials and processing steps. Develop a plan for how these may be integrated into a complete mask making process, evaluating effects between the various material properties and processing steps. Evaluate this plan against the many, varied requirements of masks in semiconductor manufacturing.

Phase II: Fabricate prototype samples and characterize. Deliver samples to third parties for independent evaluation. Evaluate projected costs of appropriate subset in the mask fabrication sequence and under anticipated market conditions.

DARPA 90-072   TITLE: High Brightness X-ray Sources for X-ray Lithography

CATEGORY: Advanced Development

OBJECTIVE: To develop x-ray sources suitable for x-ray lithography in the semiconductor manufacturing environment.

DESCRIPTION: X-ray lithography will be used in the future to make semiconductor devices having features of 0.25 micrometers and below. Key components of the lithography system include the x-ray source, the mask, the mask-to-wafer aligner, and the resist. In current practice, the x-ray wavelength is in the 0.7-2 nanometer range and the mask is a gold absorber on a thin silicon membrane. The intensity of the x-ray beam, the size of the equipment, and capital investment are significant contributors to the cost-effectiveness of the lithography system. The synchrotron source has appropriate wavelength and intensity, but it has undesirable characteristics of large size, high capital investment, and a lack of granularity, i.e., incremental increase in production or graceful degradation of production with synchrotron failure. To date, conventional anode sources and plasma sources have not demonstrated desired intensity. The source should satisfy a wide range of characteristics suitable for the semiconductor manufacturing environment: intensity, equipment size, reliability, cost, safety, etc. The desired beam characteristics include wavelength, about 1 nm; intensity, >50 milliwatts average power at the wafer; and divergence < 1 milliradian.

Phase I: Select a candidate approach. Evaluate this against the projected needs for x-ray lithography. Compare with appropriate characteristics (throughput, size, cost, reliability, environmental, etc.) of current optical lithography equipment.

Phase II: Fabricate a prototype and characterize. Arrange for independent evaluation by interested third parties. Develop a plan for integration with an equipment vendor. Evaluate projected costs of the source subsystem under anticipated market conditions.

DARPA 90-073   TITLE: Photoresists for Optical Lithography at Wavelengths of 250 nm or Less

CATEGORY: Exploratory Research

OBJECTIVE: To provide photoresists capable of high-resolution optical lithography with illumination sources having wavelengths in the 248- to 193-nm range. These resists must be suitable for semiconductor manufacturing with feature sizes from 0.5 to 0.25

microns.

DESCRIPTION: As semiconductor lithography progresses from one-micro feature sizes to 0.5-0.25-micron feature sizes, requirements for photoresist materials shift and become more demanding. In particular, the use of short-wavelength illumination sources -- mercury lamps in the 250-nm region, KrF lasers at 248 nm, and ArF lasers at 193 nm, requires new resists that are active at these wavelengths. The resists must also be reproducibly manufacturable and reliable in a rigorous production environment.

Phase I: Establish the detailed criteria for short-wavelength resists for semiconductor manufacturing. Complete this by extensively interacting with producers and developers of next-generation optical lithography systems. Identify candidate materials that have the potential to meet these criteria, and establish a thorough test plan.

Phase II: Evaluate the candidate resist materials and correlate their properties to optical lithography requirements. Fully characterize one or more resists and evaluate them for manufacturing.

DARPA 90-074   TITLE: Fabrication of Micro-optical Components

CATEGORY: Advanced Development

OBJECTIVE: To apply planar processing techniques to the manufacture of micro-optical components.

DESCRIPTION: Achieving the itegration of many different device functions (light generation, control, modulation, detection) in a single monolithic or hybrid structure requires a means of efficiently coupling light between the functional centers of the integrated device. In current practice, this is performed using discrete optical components manufactured using scaled-down implementations of traditional optical fabrication procedures (molding, polishing, etc.) and positioned using mechanical manipulation under a microscope. In order to meet anticipated future requirements for size, packaging, and cost, it will be necessary to develop alternative manufacturing technologies. For example, it is possible to apply photolithographic techniques to the fabrication of lenses and other optical elements in such materials as silicon and germanium. Another approach is to perform the necessary optical function in the native material used for lasers and detectors. An example would be the formation of reflecting surfaces to deflect the output of a semiconductor laser, thereby creating a surface-emitting device.

Phase I: Identify candidate devices for fabrication by novel means. Describe potential alternative manufacturing techniques which may lead to cost and performance advantages.

Phase II: Validate both the optical design and the potential value of the manufacturing process identified in Phase I. Fabricate and test one or more of the devices considered using the techniques developed.

DARPA 90-075   TITLE: Fabrication Techniques Related to Monolithic Photonic Transmit/Receive Modules

CATEGORY: Advanced Research

OBJECTIVE: To develop device fabrication technology applicable to integrating the functions required for fiber optic transmission and reception on a single monolithic chip.

DESCRIPTION: The transmit/receive (T/R) module is the device forming the interface between electronic data processing circuitry and the fiber optic transmission line. The functions required of this interface include converting from logic levels to light emitting diodes or laser drive waveforms, coupling to the fiber (bilaterally), and converting received optical signals to logic levels for subsequent processing. Currently, these functions are performed in separate semiconductor chips, fabricated in different material systems, and integrated on a hybrid substrate. Because of the very large number of these devices that will be required in communications, in local area networks, and optical backplane structures for advanced computation systems, the cost, size, and weight associated with hybrid structures cannot be tolerated. Achieving these functions in a monolithic structure will lead to very significant advantages provided that laser, detector, optical coupler, laser driver and limited logic functions can be achieved in a single chip of a single material system. Maximum compatibility with low loss optical fiber would be desirable.

Phase I: Determine the individual device functional performance parameters needed to meet the overall T/R performance objectives. Translate these parameters into specifications for material layer topology and doping. Validate the performance of this design analytically. Identify the preferred material growth and chip processing technologies for producing this design.

Phase II: Fabricate individual chips in the common material system to separately demonstrate the device functions and integration potential discussed above. Measure the performance and compare it with the design goal.

DARPA 90-076   TITLE: Fabrication/Materials for Assembly of Laser Diode Arrays

CATEGORY: Advanced Development

OBJECTIVE: To advance the development and fabrication of solid-state lasers that will have the spectral distribution and power output appropriate for large screen direct projection displays.

DESCRIPTION: Large screen projection display devices based on gas lasers have been designed and built. Such systems, however, are rather large, heavy, require high levels of electric power and are very expensive. Solid state lasers offer an alternative for a much more efficient, compact and less expensive projection system. Solid state laser technology is not yet sufficiently advanced to permit an implementation of a full color projection system. This project is directed toward the development of new materials to be used in solid state laser devices for this application. Materials that would lead to a blue laser (ultimate objective: 3 Watts output, CW at 473 nm) are of particular interest.

 Phase I: Identify one or more materials that are probable candidates for solid state laser light generation of the appropriate chromaticity and intensity for a projection system. Develop a plan for processing the material as required by the application.

 Phase II: Develop final design and fabricate prototype samples of the material. Test the material in lasing configurations. Measure and report the performance characteristics.

DARPA 90-077 TITLE: In-situ Process Monitoring for Metal Organic Chemical Vapor Deposition Material Growth

CATEGORY: Exploratory Research

OBJECTIVE: To develop mercury cadmium telluride metal organic chemical vapor deposition (MOCVD) growth methods which sense material characteristics in the growth reactor and optimize material growth by using real time feedback to adjust growth conditions.

DESCRIPTION: MOCVD of mercury cadmium telluride material is currently controlled by adjusting the reactor parameters, such as temperature, pressure and gas flow rates. Implementation of these controls has demonstrated the feasibility of growing a high quality material over wafers as large as two inches in diameter. However, poor reproducibility of growth conditions and undetected changes in the reactor environment have resulted in a poor material yield and precluded the extension of the growth to larger area wafers. The material is evaluated subsequent to material growth and a detailed analysis of results categorizes the material for specific array applications. This lengthy process of growth, characterization and analysis adds to the cost of the product and increases the time required to complete the cycle from material growth to focal plan array fabrication. Innovative characterization techniques, which do not disturb material properties and have the capability to map material properties over the wafer, are required to qualify the material in-situ and to provide real item feedback for control of material quality as the material is grown. A reactor design incorporating this unique control mechanism will dramatically reduce array cost by improving the yield of high quality material and by providing a measure of the material quality prior to the array processing, where substantial value is added to the product.

 Phase I: Demonstrate characterization techniques which have the potential to non-destructively characterize the material and map material properties over the wafer. Integrate the non-destructive characterization technique into a MOCVD reactor design.

 Phase II: Implement reactor design incorporating in-situ characterization and control methodology, and demonstrate improvements in mercury cadmium telluride material yield and uniformity.

DARPA 90-078 TITLE: Graphical Displays for Manufacturing Process Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To develop the technology for improved simulation of the manufacturing process of complex shaped mating surfaces and interfacing components.

DESCRIPTION: Manufacturing process simulation requires the ability to present highly detailed, accurate, moving, three dimensional graphic images. It requires accurate representation of complex shaped mating surfaces and interfaces of components, and how their relationship changes during the manufacturing process. Components representation may have to be changed from opaque to translucent to enable display of hidden views.

 Phase I: Design innovative display and related hardware technology that allows the display of computer generated, three dimensional objects with smooth motion and a wide range of colors.

 Phase II: Demonstrate the proposed technology.

DARPA 90-079 TITLE: Simulation and Modeling to Predict Life Cycle Product Costs

CATEGORY: Engineering Development

OBJECTIVE: To develop and test operational on-site field procedures and equipment to detect cavities suitable for nuclear decoupling near quarries, open mines, and drill-sites.

DESCRIPTION: There is substantial research on tunnel detection and on mineral exploration that is relevant to this subject. In addition, mining engineers and quarry operators may be able to suggest practical clues or means, accounting or physical, of detecting or preventing secret activity. Cavities of interest would range from radii of 10 to 50 meters at depths or at distances from tunnels of up to 1000 meters.

Phase I: Survey the existing literature and experts on this subject. Consult with mining and quarry engineers and operators. Outline suitable procedures and systems and define their probable capabilities. Propose suitable experiments for Phase II.

Phase II: Execute experiments in detecting hidden cavities. Evaluate results and propose designs for operational procedures and systems.

DARPA 90-080   TITLE: Inexpensive Gigabit Local Area Network Technology

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches and configurations for a local area network (LAN) that can support user data rates up to 1 Gbps.

DESCRIPTION: Designs are sought for Gbps LANs that could be implemented with current technology. These designs must be compatible with future computer and workstation architectures, must provide adequate performance, and must have the potential to lead to relatively inexpensive implementations. It is essential that the LAN design be amenable to standardization.

Phase I: Provide a detailed design, including description of hardware and protocols, analysis (and/or simulations) of performance, and cost projections.

Phase II: Construct and test demonstration hardware.

DARPA 90-081   TITLE: Terabit-per-second Local Area Network Technology

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches and configurations for a local area network that can support aggregate data rates of 1 Tbps (10^{12} bps).

DESCRIPTION: Designs are sought for innovative LANs that will be able to support a mix of many high-speed and very-high-speed devices. The designs should be scalable to data rates higher than 1 Tbps, and they should not depend upon technology that is unlikely to be generally available by the mid-1990s.

Phase I: Provide a conceptual design, including a description of hardware and protocols, an analysis (and/or simulations) of performance, and an explanation of the limitations and the scalability of the architecture.

Phase II: Construct and test demonstration hardware.

DARPA 90-082   TITLE: Speech Recognition Modules

CATEGORY: Exploratory Development

OBJECTIVE: To establish a library of reusable software modules embodying state-of-the-art techniques for speech recognition.

DESCRIPTION: Considerable progress has been made in the development of speech recognition techniques, but much government-funded technology resides in machine- and site-dependent software. A library of reusable component modules is needed to accelerate the transfer of this technology to potential users. The modules must be written in a standard, high level language and have clean, well-defined interfaces, structures, and descriptions. Complex functions are to be accomplished by combining several lower level modules.

Phase I: Acquire existing speech recognition software from researchers. Develop framework for constructing a library of speech recognition modules. Code and document a few modules.

Phase II: Significantly expand the initial library. Use it to construct a real application. Successfully export the library to other sites.

DARPA 90-083   TITLE: Acoustic Preprocessor for Speech

CATEGORY: Exploratory Development

OBJECTIVE: To develop hardware and software exploiting knowledge of human auditory processing to serve as a robust front-end for speech recognizers.

DESCRIPTION: Recent discoveries concerning the early stages of human auditory processing could be exploited in algorithms to improve the accuracy and robustness of speech recognizers. Sound ideas are needed to create those algorithms, and a hardware implementation is needed for real-time operation. The resulting acoustic preprocessor could either modify the digitized signal or extract features for use by a speech recognizer.

Phase I: Develop and test a software version of an acoustic preprocessor. Sketch out the design for a hardware version.

Phase II: Refine the algorithms as needed. Complete the hardware design. Build several copies of the preprocessor hardware.

DARPA 90-084   TITLE: Interface Standards for Simulation Systems (i.e., SIMNET to BBS to JESS)

CATEGORY: Exploratory Development

OBJECTIVE: To explore techniques for interfacing warfighting simulations for interoperable exercises.

DESCRIPTION: Concepts and ideas are needed to interconnect, both vertically and horizontally, military simulations. The emphasis should be on the communications protocols and the database interchange.
Phase I: Prepare detailed concepts and analyze the potential applications
Phase II: Execute and test demonstration software and hardware.

DARPA 90-085   TITLE: High Definition Video Technology Based Head Mounted Displays for Visualization of Real-Time Systems

CATEGORY: Exploratory Development

OBJECTIVE: To explore new and innovative approaches and configurations for high definition video head mounted displays.

DESCRIPTION: Concepts are sought for innovative and novel approaches and configurations for high definition video technology based head mounted displays. The approach should consider use of innovative visualization techniques, and include size, weight, power and the need to interface the display to real-time systems in their discussions. New ideas for head mounted display alternatives for potential use in current and future weapon systems are desired.
Phase I: Provide a detailed refinement of the proposed approaches and configurations and conduct a performance analysis of proof-of-principle hardware.
Phase II: Construct and test demonstration hardware.

DARPA 90-086   TITLE: Low Cost Portable Computer Generation Image Machines

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel machines for rendering objects in low cost portable equipment.

DESCRIPTION: Concepts are sought for novel approaches to low cost image generation machines that can be used in portable applications such as heads-up displays and very light weight, high resolution terminals. Approaches should emphasize special purpose hardware for rendering high resolution objects at high speed with low power.
Phase I: Identify and architect the system, demonstrating how the proposed approach significantly advances the state-of-the-art. Augment simulation results by a detailed cost, performance, and power dissipation study.
Phase II: Construct and test the demonstration hardware.

DARPA 90-087   TITLE: Low Cost Reconfigurable Generic Computer Workstations for Simulation Research/Development/Analysis

CATEGORY: Exploratory Development

OBJECTIVE: To explore concepts for rapidly prototyping simulators, simulations, and operational equipment in a testbed environment.

DESCRIPTION: Concepts are sought for creative, innovative, and imaginative ways and means of creating modular (mix and match) workstations for simulation in a research and development environment.
Phase I: Prepare ideas and concepts for presentation in graphic format.
Phase II: Execute, test and analyze selected concepts.

DARPA 90-088   TITLE: Virtual World Interactions Using Heads-on Displays and Magic Glove Interaction

CATEGORY: Exploratory Development

OBJECTIVE: To explore, in conjunction, novel algorithms and hardware for virtual world interaction.

DESCRIPTION: Concepts are sought for novel approaches to virtual world interaction algorithms and hardware. Approaches that significantly improve the fidelity, usability, responsiveness, or cost-performance of such equipment are required. Low-resolution concepts are not of interest.
    Phase I: Design a brass-board system connected to a personal computer or workstation. Optimize "feel" of interface.
    Phase II: Address manufacturability and software concerns. Demonstrate prototype in a Military application.

DARPA 90-089   TITLE: Low Power Complementary Metal Oxide Semiconductor Design Tools

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel design tools which minimize power for complementary metal oxide semiconductor (CMOS) circuits.

DESCRIPTION: Concepts are sought for novel approaches to minimizing power consumption in CMOS devices and circuits, even at the expense of circuit size or density. Approaches must be capable of being incorporated into design tools.
    Phase I: In detail, refine the concepts from circuit design to layout and provide detailed cost/performance analysis as applied to nominal size circuits. Software module development will be necessary to demonstrate proof of concept, and detailed analysis of its scalability to large circuits is required.
    Phase II: Develop tools, supporting documentation, and test cases which demonstrate and prove the principles. Tools must be designed with an open architecture, and transportable between hardware platforms.

DARPA 90-090   TITLE: High Performance Flexible Interconnect Technology

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel approaches to electro mechanical system design using flexible interconnect technologies.

DESCRIPTION: Concepts are sought for novel approaches to interconnect electrical-mechanical components for miniaturized systems. Emphasis should be on high performance systems which operate greater than 100Mhz, and which minimize power and weight.
    Phase I: Provide a detailed refinement of the proposed concepts and develop an optimized design of a system, including thermal analysis. Analyze tradeoffs and compare to conventional techniques.
    Phase II: Construct, test, and optimize demonstration of technology. Develop approach, software tools, etc. for applying to larger systems.

DARPA 90-091   TITLE: Small Scale, Special Purpose Hardware Accelerators

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel ideas for computer hardware accelerators which can achieve 1000X over general purpose computing.

DESCRIPTION: Concepts are sought for innovative and novel ideas for computer hardware accelerators which demonstrate at least 1000X performance over general purpose solutions. Concepts must be implemented and described in systems context and include both hardware and software interfaces.
    Phase I: Provide a detailed refinement of the proposed concept and develop the detailed design of the accelerator. Describe its simulated performance, its use in conjunction with an existing computer system, and the interfaces required for operation.
    Phase II: Construct, test, and optimize the accelerators. Provide detailed analysis of its benefits, benchmark results, and interface specification.

DARPA 90-092   TITLE: Rapid Prototyping Techniques and Methodologies

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel approaches for rapidly prototyping complex electromechanical systems.

DESCRIPTION: Concepts are sought for innovative and novel ideas to cost effectively accelerate the prototype design cycle by at least 20X over traditional methods. Innovative technologies, tools, or unique application of existing techniques will be considered.

    Phase I: Provide a detailed refinement of the proposed concept, idea or tools and provide an analysis of it to electromechanical design class. Provide demonstrations for proof of principle.

    Phase II: Construct, test, and implement at least two designs employing the proposed prototyping process, and provide an assessment of its flexibility and application.

DARPA 90-093   TITLE: System Level Packaging Design Tools and Interfaces

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel approaches for designing electromechanical systems employing different packaging techniques and the design interfaces needed to be realized in alternate technologies.

DESCRIPTION: Concepts are sought for innovative and novel ideas to provide design tools for eletromechanical systems in a variety of packaging techniques. New concepts are sought to describe the necessary technical interfaces to realizing subsystems of the designs in a variety of technologies.

    Phase I: Provide a detailed refinement of the proposed concept idea and tools. Describe, and demonstrate for proof of principle, interfaces to various technologies.

    Phase II: Develop tools, supporting documentation, and test cases which demonstrate and prove the principles. Tools must be designed with an open architecture and transportable between hardware platforms.

DARPA 90-094   TITLE: Technology Independent, Performance Driven Design Tools

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel approaches of designing electronic systems which optimize on performance criteria such as speed, density, or power, and able to be used with various integrated circuit technologies.

DESCRIPTION: Concepts are sought for innovative and novel ideas to designing systems which optimize a desired performance criteria while maintaining technology independence over a range of integrated circuit technologies. New concepts are sought to describe the necessary technical interfaces to the technology and the innovative class of design rules needed by the tools.

    Phase I: Provide a detailed refinement of the proposed concept, idea and tools. Describe, and demonstrate indicating proof of concept, technical interfaces to various technologies.

    Phase II: Develop tools, supporting documentation, and test cases which demonstrate and prove the principles. Tools must be designed with an open architecture, transportable between hardware platforms, and clearly defined interfaces.

DARPA 90-095   TITLE: Innovative, Ultra Dense, High Performance Computer Input/Output Subsystems

CATEGORY: Exploratory Development

OBJECTIVE: To explore ultra dense, high performance computer input/output (IO) subsystems for use with embedded computers.

DESCRIPTION: Concepts are sought for novel approaches to ultra dense high performance computer I/O subsystems for embedded applications where issues of size, weight, and power dominate the concerns. Parallel processing systems are of greatest interest.

    Phase I: Refine the proposed system in detail. Augment simulation results by a detailed cost, performance and power dissipation study.

    Phase II: Address manufacturability and software concerns. Demonstrate prototype in a Military application. Equipment must conform to the specifications of a widely accepted standard.

DARPA 90-096   TITLE: Vision Environment Components

CATEGORY: Exploratory Development

OBJECTIVE: First, to acquire libraries of object models and components using relatively new techniques for building representations

of complex physical objects (i.e., natural terrain populated with objects such as roads, bridges, bushes and trees) from sensor data and a prior stored knowledge. Second, to demonstrate the object models utility in recognition tasks.

DESCRIPTION: Substantial progress has been made within the DARPA image understanding (IU) community on the basic techniques for interactive and automatic visual modeling and recognition (i.e., effective techniques for describing, storing, and accessing models of natural objects such as rocks, bushes, ravines and cultural objects such as buildings, roads, etc.). For references, see the "Proceedings of the DARPA IU workshops (1987) and (1988)".

    Phase I: In detail, define needed extensions to existing or new object model libraries, to expand their representational descriptiveness needed to perform recognition adequately. Place the emphasis on explaining the rationale for use of an existing vision modeling tool (note that development of a vision tool is not being sought). Explicitly mention in a detailed research plan, examples of expected functionality (i.e., recognition of diverse cultural objects and natural objects from range and intensity data) and total number of objects expected at six month intervals during Phase II development.

    Phase II: Construct and demonstrate new object models and their addition to existing model libraries, using the chosen vision environment tools. Deliver extended model libraries, as required, to designated Military agencies.

DARPA 90-097   TITLE: Case-based Reasoning Modules

CATEGORY: Exploratory Development

OBJECTIVE: To acquire precedent cases and exemplary prototype transformation modules that demonstrate new functionality or new applicability for case-based reasoning (CBR).

DESCRIPTION: The CBR paradigm has shown promise in both reducing the cost of initial knowledge acquisition and transfer of knowledge from an old case to a new problem situation (c.f., Proceedings of DARPA CBR workshops (1987) and (1988)). Nevertheless there remain many open technical questions (i.e., indexing and knowledge representation) as well as considerable need for further exploratory applications. Toward this end, DARPA seeks suggestions for novel ways to extend the technical base of experience in CBR into a new functional areas (i.e., recognition of deception, temporal reasoning, adversarial reasoning, etc.), new task domains (i.e., planning/scheduling, diagnosis, etc.) or new application frontiers (i.e., medical law, international treaties, architecture, etc.). Emphasis should be on novelty in the space of functionality/task/application where an existing case base is known to exist and is available for further development.

    Phase I: In detail, define needed extensions to existing CBR to expand its representation, etc. for integration into a prototype CBR system. Explain the rationale for use of the plans to extend functionality of an existing CBR tool (note that development of a CBR tool is not being sought). Examples of expected functionality and behaviors expected at six month intervals during Phase II development should be illustrated in the detailed research plan resulting from this phase.

    Phase II: Construct and demonstrate new functionality/task/application. Deliver case base and associated transformation modules as required.

DARPA 90-098   TITLE: Nonlinear Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: To explore new and innovative approaches, algorithms and applications for nonlinear signal processing.

DESCRIPTION: Concepts are sought for innovative and novel approaches for nonlinear signal processing. The approach should include, as a minimum, consideration of the theoretical advantage over linear signal processing, the computational complexity, and potential applications.

    Phase I: Provide a detailed refinement of the proposed algorithms and the analysis of expected performance of the algorithms for at least one application.

    Phase II: Develop software to implement the proposed algorithms for the application(s) analyzed in Phase I, and demonstrate the actual performance with real data.

DARPA 90-099   TITLE: Scalable Algorithms and Software Library Modules for Scalable Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: To explore novel ideas for scalable algorithms and software library modules for scalable parallel computers that can become functioning software on highly parallel multicomputers and multiprocessors.

DESCRIPTION: Concepts are sought for innovative and novel ideas for scalable algorithms and computing software libraries of beta release quality which focus on the use of highly parallel multicomputers and multiprocessors. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed software: collection of algorithms, library, or tool. Focus a description of its use in current or developing parallel computing environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module (code for scalable parallel computer): collection of algorithms, library, or tool. Develop a users manual which clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. Deliver the magnetic media in ASCII form and in Unix Tar format.

DARPA 90-100   TITLE: New Techniques for Wide-band Video Data Compression

CATEGORY: Basic Research

OBJECTIVE: To identify and exploit techniques for reducing data link bandwidth while still providing the quality and quantity of data needed by unmanned air vehicles (UAV) to perform their tasks.

DESCRIPTION: The Services are developing a family of UAVs, and other systems, that employ video or other wide-band sensors to collect data that must be transmitted over an extended range by a radio frequency data link. Increasing a signal's bandwidth increases the signal losses which adversely affects data link range and anti-jamming performance (all other factors being equal). Conversely, reducing the video bandwidth would increase the link's performance in these areas. Therefore, there is a need for a bandwidth compression/decompression system, provided that the quality of the decompressed (reconstructed) video is good enough for the UAV to perform its tasks.

Phase I: Investigate and develop compression/decompression techniques. Develop an experimental approach for empirically assessing performance.

Phase II: Design and fabricate bread board hardware. Integrate hardware into the UAV system, then demonstrate and assess performance.

DARPA 90-101   TITLE: A Requirements Language for Tracking Autopilot Systems

CATEGORY: Basic Research

OBJECTIVE: To standardize specific language which delineates the features and performance parameters of a guidance system which must track a target and guide a vehicle.

DESCRIPTION: There is a need for a standard specification language for tracking autopilot systems from which software and hardware requirements can be automatically extracted. An ideal model should connect graphics and text features of design techniques and provide interfaces for hardware computer aided design (CAD) and software generation.

Phase I: Investigate and catalog standard features of design specifications for tracking autopilot systems, and define a standardized specification language grammar and syntax.

Phase II: Develop a parser to generate, from the design specification language, parameter inputs for hardware CAD tools and software design tools.

DARPA 90-102   TITLE: Feature-based Design Methods for Predictive Design Paradigms

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop and demonstrate innovative techniques which utilize feature-based design methodologies in a conceptual design process which is predictive of productivity and manufacturability considerations.

DESCRIPTION: Emerging technologies in artificial intelligence/expert systems have shown great promise as tools for evaluation of conceptual designs for productivity and manufacturability considerations. Although conventional computer aided design (CAD) technologies have not demonstrated the capability to adequately capture and manage the design intent knowledge necessary to allow for prediction or subsequent productivity considerations, feature-based design theory and preliminary efforts have shown the potential

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of providing a fundamental model for predictive designs.

Phase I: Identify and demonstrate innovative feature-based design methodologies which capture and manage design intent knowledge as a fundamental predictive design model.

Phase II: Develop a feature-based design system which captures or manages the predictive design as a knowledge base suitable for manipulation by a productivity expert system.

DARPA 90-103   TITLE: Integration of Expert System for Process Planning and Feature-based Designs

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop and demonstrate innovative artificial intelligence/expert system techniques which integrate feature-based designs and process planning considerations.

DESCRIPTION: Artificial intelligence/expert system techniques have demonstrated the ability to address complex reasoning tasks required for process planning.   Feature-based design theory and preliminary efforts have shown the potential of providing a fundamental model for capture and manipulation of design knowledge.   However, the two technologies have not been sufficiently integrated to allow design features to automatically influence process planning considerations.

Phase I: Identify and evaluate innovative artificial intelligence/expert system techniques which integrate feature-based design and process planning technologies.

Phase II: Demonstrate promising techniques identified in Phase I.

DARPA 90-104   TITLE: Development of a Compact Eye-safe Laser Using Laser Diode Arrays

CATEGORY: Exploratory Research

OBJECTIVE: To develop coherently coupled laser diode arrays operating in the eye-safe wavelength region beyond 1.54 uM.

DESCRIPTION: Compact eye-safe lasers with good beam quality are needed for numerous tactical applications.   High power laser diode arrays operating in the 1.54 uM wavelength region are needed both to pump solid state laser materials and to provide compact laser sources through coherently coupled laser diodes.   Laser diode arrays with low output powers have been demonstrated in this wavelength region.   The goals of this program are to demonstrate high power surface emitting laser diode arrays in the eye-safe wavelength region.

Phase I: Demonstrate high power laser diodes in the 1.54 uM wavelength region and develop innovative design concepts for coherently coupled two dimensional laser diode arrays.

Phase II: Demonstrate coherently coupled high power laser diode arrays.   Typical output powers are 10 watts or greater.

DARPA 99-105   TITLE: Development of Passive Q-Switches in the Mid-infrared Spectral Region

CATEGORY: Exploratory Research

OBJECTIVE: To develop passive Q-switches in the mid-infrared spectral region.

DESCRIPTION: Q-switched mid-infrared lasers have numerous tactical applications.   Passive Q-switching solid state lasers in the mid-infrared eliminates the moving parts making the lasers compact and light weight.   The goals of this program are to develop and demonstrate passive Q-switches for mid-infrared solid state lasers.

Phase I: Examine the materials requirement for efficient passive Q-switches in the mid-infrared region and demonstrate the Q-switch operation.

Phase II: Demonstrate passive Q-switches at high repetition rates and at high peak powers in the mid-infrared.   Address materials development and reproducibility issues.

DARPA 90-106   TITLE: Detection of Chemical Agents by Directed Energy

CATEGORY: Exploratory Development

OBJECTIVE: To develop a portable, compact and light-weight directed energy device to detect chemical agents, i.e., ether, illegal drugs, etc.

DESCRIPTION: Current methods of locating illegal drugs and their manufacturing facilities are quite inefficient.   Specially trained dogs are used to sniff baggage in customs.   The sensitivity of a dog's nose is very good but it deteriorates very quickly after a prolonged period.   The development of a compact, remote sensing device using directed energies, such as lasers, particle beams or

microwaves for detection of illegal drugs and their manufacturing sites, is desired.
 Phase I: Develop the methodology for remote sensing of drugs or drug facilities.
 Phase II: Perform a proof-of-principle experiment which can demonstrate the features of Phase I.

DARPA 90-107   TITLE: Development of Nonvolatile Memories Using Thin-film, Ferroelectric Materials

CATEGORY: Basic Research

OBJECTIVE: To develop materials, deposition technology or characterization technology for ferroelectric nonvolatile memories.

DESCRIPTION: DARPA is seeking innovative approaches to the utilization, deposition, and characterization of thin-film ferroelectric ceramics for nonvolatile memories. Endurance and retention characteristics of the ferroelectric ceramics are extremely important. Techniques which produce single crystalline or highly oriented films are of interest. The ferroelectric thin films must be compatible with either silicon or gallium arsenide integrated circuit technologies.
 Phase I: Initiate effort as described above by beginning exploration of novel materials, deposition techniques and equipment, or characterization technology. Clearly demonstrate potential viability of the selected approach(es).
 Phase II: Demonstrate the initial concept's applicability. For example, develop equipment for deposition of ferroelectric thin films.

DARPA 90-108   TITLE: Development of Circuit Architectures Using Quantum Well Devices

CATEGORY: Basic Research

OBJECTIVE: To explore and develop circuit architectures of general applicability that use quantum well devices.

DESCRIPTION: Innovative approaches to using quantum well devices in electronic circuits are required. Both analog and digital applications are acceptable. The proposal must address the potential advantages of using quantum well devices in the type of circuit chosen.
 Phase I: Develop circuit architecture using quantum well devices. Address questions about whether the envisioned architecture has individual device performance tolerances that allow good manufacturing yields. Explore the applicability of the chosen architecture.
 Phase II: Demonstrate initial concepts developed under Phase I by fabricating and characterizing quantum well circuits. Compare performance, power consumption, circuit density, and potential manufacturability to those obtained by conventional technologies.

DARPA 90-109   TITLE: High Resolution Dopant, Impurity and Defect Spatial Profiling of Compound Semiconductors

CATEGORY: Exploratory Research

OBJECTIVE: As compound semiconductor devices achieve ever higher performance, the exact knowledge of dopant and impurity profiles becomes increasingly more important. Profiles or dopants and compensating impurities need to be quantified with greater spatial accuracy. The dynamic range for these determinations must also be extended, both to very high concentrations as might exist in heterojunction bipolar device bases, and to low concentrations as found in implant tail regions of field-effect or modulation-doped transistors.

DESCRIPTION: Nondestructive techniques will be preferred; however, all techniques that promise at least 10-nanometer depth resolution and a 10% accuracy in dopant concentration in the range of 10^{14} to 10^{20} will be considered. Different techniques may be useful for the high and low ranges; thus, proposals that promise to solve the problem for either the high or low concentration range, or both, are solicited.
 Phase I: Demonstrate the capability of the technique for a limited number of samples. Establish a reasonable degree of confidence in the accuracy and versatility of the proposed scheme.
 Phase II: Construct a useful measurement tool that will significantly advance the state of the art of compound semiconductor profiling equipment.

DARPA 90-110   TITLE: Development of New Energetic Materials

CATEGORY: Exploratory Research

OBJECTIVE: To explore the synthesis and formulation of new energetic materials that have both high density and are sufficiently stable to permit possible utilization in explosives and propellants.

DESCRIPTION: New energetic materials that have densities and stabilities greater than HMX (high melting explosive) are needed for performance enhancement in numerous conventional military weapon systems for use as both propellants and explosives. Included would be new chemical methods to synthesize polycyclic nitramines and other energetic species.

Phase I: Emphasize the development of potential synthesis routes, and predict densities and heats of formation.

Phase II: Involve the synthesis of new energetic species, and determine critical properties, including stability and development of formulations that would enable their assessment as potential materials for novel, high performance explosives and/or propellants.

DARPA 90-111   TITLE: Advanced Fouling Control Coatings

CATEGORY: Exploratory Research

OBJECTIVE: To develop fouling control coatings as replacements for toxic anti-fouling paints.

DESCRIPTION: Certain fluoropolymers and silicones are effective for use as fouling-release coatings, provided hull cleaning practices are adequate. However, it would be desirable to have the release characteristics of such coatings sufficiently effective to require little, if any, mechanical cleaning of the hull. Coatings which combine the best properties shown by silicones and fluoropolymers in one polymer type are sought. In addition to fouling release, surface properties are sought which inhibit fouling, e.g., those which would control barnacle settlement.

Phase I: Synthesize fluoropolymers which have release properties more like the silicones, but without their low toughness. Evaluate the best of these in fouling tests on small panels. Carry out morphological, chemical and physical surface analysis to correlate fouling behavior with surface properties.

Phase II: Scale the synthesis reactions toward commercial volume, and in full-scale, evaluate the reactions on hulls.

DARPA 90-112   TITLE: Development of New Ceramic Composite Materials

CATEGORY: Exploratory Research

OBJECTIVE: To synthesize and process fiber reinforced and whisker reinforced ceramic matrix composites, with the goal of increasing room temperature and elevated temperature toughness and strength to values substantially above those for monolithic ceramics.

DESCRIPTION: Ceramic composites are of interest to the Military for a variety of applications: high temperature structural materials for aircraft and missiles, armor, gun barrel liners, and a variety of wear resistant applications. Novel processing techniques to produce net shape low cost composites will be given high priority.

Phase I: Process ceramic composition to dense bodies, determine room temperature toughness and strength, and conduct microstructural characterization.

Phase II: Optimize mechanical properties at both room temperature and elevated temperature.

DARPA 90-113   TITLE: Determination of New Ways of Enhancing the Compressive Behavior of Organic Composites

CATEGORY: Exploratory Research

OBJECTIVE: To investigate the nature of compressive properties of high performance organic composites, and to develop capabilities for significantly improving poor compressive properties through modifications and developments in the fiber, the matrix, and the fiber matrix interface and in the design of the organic composite structure.

DESCRIPTION: Enhancement of the compressive properties of organic composites has and continues to be an elusive goal. Since the utilization of organic composites in military weapon systems is ever increasing, so is the need to enhance compressive behavior of these widely used materials.

Phase I: Explore the advantages to be gained in the compressive properties of organic composites via an investigation of the properties/behavior of fibers, matrices, interphases and overall structure and design. Also provide qualitative estimates for enhanced compressive behavior.

Phase II: Select one or more key elements (fiber, matrix, interface, and design) and develop an organic composite. Extensively determine and measure compressive properties and behavior, and quantitatively compare this composite with prevalent organic composites.

DARPA 90-114   TITLE: Application of High Temperature Superconductivity to Electronic Packaging

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CATEGORY: Exploratory Research

OBJECTIVE: To determine how high temperature (nominally 80K) superconducting materials can be applied to electronic packaging to enhance speed, frequency response, and minimize power dissipation within the electronic circuits.

DESCRIPTION: The new (circa 1987) ceramic oxide high temperature superconductors offer the possibility of revolutionary advances in the capabilities of electronic components and circuitry. The initial insertion of this technology into integrated circuits would be the replacement of normal metal interconnects by superconducting leads, allowing circuits to transport signals without dissipation and with reduced dispersion.

Phase I: Conduct an analysis of the advantages to be gained by the insertion of superconducting interconnects into prototypical integrated circuits. Investigate the electromagnetic response of simple packaging geometries for operation of interconnects and semiconductor elements at a temperature of 80K. Consider the mechanical response upon immersion in a cryogenic fluid, and give thought to compensation of the materials properties to assure mechanical integrity.

Phase II: Select a specific integrated circuit (IC) design, develop detailed analyses of the performance characteristics of the complete package with superconducting materials insertion, and define design goals in the production of the next generation electronic packages.

DARPA 90-115   TITLE: Unique Applications for Artificial Neural Networks

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop prototype Artificial Neural Networks (ANNs) for applications for which ANNs provide a unique solution (i.e., applications for which, relative to competing, technologies, ANNs can be demonstrated to be the only technology adequate for the application).

DESCRIPTION: This SBIR solicitation is intended to elicit proposals with outstanding potential to demonstrate particular advantages of artificial neural networks (ANNs) in systems that perform challenging tasks that are at or beyond the limits of capability of conventional information processing systems. Since one important objective of this solicitation is to discover important unusual and under-recognized "niches" for application of ANN technology, proposals to carry out development activities in areas outside the mainstream of conventional and ANN information processing research will receive particularly favorable consideration. Proposals that address simplistic or unimaginative tasks or that promise incremental performance improvements in tasks for which there are well-developed "conventional" solutions are considerably less likely to be supported.

Phase I: Provide a conceptual design and laboratory demonstration of the system with documented evidence that the system will significantly outperform competing technologies.

Phase II: Extend the laboratory demonstration to a compact, prototype system (that may include tailored ANN hardware components) that can be used to demonstrate the uniqueness of the ANN solution.

DARPA 90-116   TITLE: Nonstandard Control Theory

CATEGORY: Exploratory Research

OBJECTIVE: To develop a control theory that is applicable in complicated manufacturing environments.

DESCRIPTION: Formulation of a control theory in environments that are too complicated to be described by the usual feed back techniques. The approach should include the use of local simulation or heuristics to design controls in manufacturing environments that cannot currently be controlled by standard techniques. The proposal should include the detailed discussion of a manufacturing process of current importance.

Phase I: Develop the abstract setting for the control theory.

Phase II: Apply the abstract approach to the control of a manufacturing process.

DARPA 90-117   TITLE: Spatial Light Modulator Utilizing Deformable Mirror Devices for Infrared Projection for Hardware-in-the-loop Simulation Applications

CATEGORY: Exploratory Development

OBJECTIVE: To design and fabricate a prototype infrared (IR) projection system which utilizes a spatial light modulator (SLM) based on deformable mirror devices (DMDs) for application in hardware-in-the-loop (HWIL) simulations.

DESCRIPTION: Several weapon systems are currently under development throughout all branches of the Military which utilize imaging IR focal plane arrays (FPAs) for target detection and intercept. Conventional IR projector performance limitations have forced the exclusion of the FPA hardware from the HWIL simulations which are necessary to adequately access weapon system performance. Therefore, innovative IR projection techniques are needed to overcome these limitations. Advances in integrated circuit technology have recently made large monolithic DMDs possible. Broadband SLMs appear to be an obvious extension of this technology. Accordingly, they could lead to the development of an innovative IR projection system for application in HWIL simulations.

Phase I: Provide a conceptual design of, and demonstrate within the laboratory, an IR projector which utilizes available DMDs as IR SLMs.

Phase II: Extend and upgrade the laboratory demonstration of the IR projection system to a prototype device for use in HWIL simulations of imaging IR missile systems.

DARPA 90-118   TITLE: Applications for Acoustic Charge Transport Technology

CATEGORY: Exploratory Development

OBJECTIVE: To obtain applications of acoustic charge transport devices.

DESCRIPTION: Acoustic charge transport (ACT) technology has evolved in recent years from a basic research activity to the demonstration of ACT devices which are suitable for application 6.2 and 6.3 developmental systems. ACT devices are sampled-analog signal processing elements similar in some respects to both charge-coupled devices and surface acoustic wave devices, but without the more serious limitations of either of those older technologies. The devices demonstrated to date or under development include digitally programmable transversal filters, fixed and programmable vector processors, correlators, analog memories, convolvers, and various hybrid structures. These devices all offer extremely wide bandwidths and dynamic range, low noise operation, and the advantages of implementation as monolithic gallium arsenide integrated circuits. Ultimately, the integration of ACT devices with digital processing elements on the same chip will provide extremely powerful and compact processor structures. The application areas for ACT devices include radar and radar electronic countermeasures, electronic support measures, and communications systems. The devices allow for enhanced performance of conventional concepts as well as making possible new, innovative approaches. Proposals which address the exploitation of ACT technology and devices for military systems are of current interest to DARPA. Any novel application concept will be considered, ranging from insertion into existing systems to entirely new system or subsystem concepts made potentially feasible because of ACT. Novel ACT device/processor architectures and their applications are also of interest, including research in fabrication, production and testing of such devices.

Phase I: Completely describe the proposed application, and identify and justify the required performance characteristics. Describe the proposed ACT based system while including a detailed system design and a description of operation and predicted performance. At this point, include appropriate experimental data or analysis estimated by size and cost, identification of risk areas, specifications for the ACT devices, the underlying tradeoffs, analysis, and options in the design. Document results.

Phase II: Demonstrate the proposed system in hardware. The level of demonstration (e.g. laboratory quality, field hardened, fully integrated, etc.) will depend upon the specific program as described in the Phase II proposal.

DARPA 90-119   TITLE: Algorithms to Automatically Extract Power Lines from Multi-spectral and Synthetic Aperture Radar
                        Imagery

CATEGORY: Exploratory Research/Advanced Development

OBJECTIVE: To develop automated methods for geolocating powerlines and related obstructions from multispectral imagery and/or synthetic aperture radar imagery.

DESCRIPTION: High voltage powerlines, powerline towers, and related obstructions present a serious hazard to low-flying aircraft. In addition, the paths that these powerlines follow provide off-road lines of communication (LOCs) for military vehicles. While these objects are well marked and well documented in friendly areas, knowledge of their exact location in unfriendly regions is often inaccurate, out-of-date, and not easily corrected, updated, or verified. Also, these objects, due to the sparse nature of their structure, are very difficult to find directly in electro optical (E/O) imagery. Techniques for automatically extracting the locations of powerlines and related obstructions using multispectral imagery data, including E/O, infrared, and synthetic operture radar (SAR), would facilitate the validation and updating of maps and map data for vast unfriendly areas.

Phase I: Efforts shall concentrate on the design of a program to develop and test techniques for extracting powerlines and related obstructions from multispectral and SAR imagery. Suitable data sets must be identified, algorithms designed, and comparative tests described. At least one technique must be developed and demonstrated and results reported. Recommendations and a plan for Phase II shall be included in the final report.

Phase II: Efforts shall concentrate on the design, development, and test of a prototype system for automatically screening imagery for powerlines and related obstructions, and extracting their geographic locations.

Phase III: Potential for integration of this capability with existing automated digital map generation, map verification, or geographic information systems technology shall be demonstrated.

DARPA 90-120   TITLE: Micro-machine Concepts and Applications

CATEGORY: Exploratory Research

OBJECTIVE: To develop an array of interconnected, sub-millimeter eletromechanical devices, and the processing system to precisely control bulk movement, shape of the entire array and/or other useful effects.

DESCRIPTION: General micro-machines, micro-motors, and micro-actuators have been developed which are smaller than 1.0 mm^3 in volume, extremely light, and with extremely rapid response times.

Phase I: Develop an innovative applications concept for appropriate individual electromechanical devices, a concept for connecting individual devices into an array, and a concept for the processing control system.

Phase II: Construct a device and perform proof-of-principle experiments.

DARPA 90-121   TITLE: New Concepts for Detecting, Classifying or Locating Mobile Objects Using Low Cost Acoustic Sensors

CATEGORY: Advanced Development

OBJECTIVE: First, to define and document a technical approach toward developing a family of low-cost, atmospheric acoustic sensors for mobile objects. Second, to demonstrate technical feasibility of detecting, classifying, or locating objects through multi-media correlation (including acoustic) technology applications.

DESCRIPTION: Microprocessor technology now perm. s increasingly sophisticated sensing techniques to be packaged in remotely operated or unattended sensors. Large areas of open water, and smaller landmass areas traversed by mobile objects present opportunities for application of advanced concer sensing technologies. New concepts for expendable devices are required which combine emerging atmospheric acoustic, seismic, and other technologies a hybrid package.

Phase I: Define, analyze and document an emerging acoustic technology sensor program which may be selected for a proof-of-concept of employment during Phase II. Establish a realistic operational concept of employment for the technology, and evaluate technical risk versus cost/benefits. Develop preliminary design concepts for implementation in Phase II.

Phase II: Implement preliminary design concepts from Phase I into a prototype configuration which can be analyzed for technical performance, manufacturing feasibility, reliability and operational employment effectiveness. Design detail will be sufficient to proceed into a third phase during which an operational prototype system may be evaluated for operational and production requirements. Conduct technical risk assessment of the final design configuration.

DARPA 90-122   TITLE: Parallel Processing Algorithms for Real-time Combat Simulation of Electronic Warfare, and Command, Control and Communications in Dynamically Scalable Domains

CATEGORY: Advanced Development

OBJECTIVE: First, to develop selected software products which will increase the parallel processing effectiveness of dynamically scalable electronic warfare (EW), communications, and command, control and communication (C^3) countermeasures (CM) simulations in real-time. Second, to design and develop specialized parallel processing architectures and software compilers which will permit the calculation of radar, infrared, and communication countermeasures effects on an interactive basis within the simulation and modeling domains.

DESCRIPTION: All Military command and control/EW/C^3CM simulations and models with human interaction fail to provide near real-time dynamic interaction between the totality of model elements for countermeasures techniques. This initiative is directed toward combining emerging technologies within the specialized countermeasures' disciplines, and creating a parallel processing architecture, methodology and ancillary software necessary to provide operational interface for selected large-scale simulations, either collocated or positioned in diverse geographical areas.

Phase I: Develop improved program structures of software for advanced parallel array processors which will permit the real-time integration with theater-level models and simulations. Recommend a follow-on development program for Phase II of this initiative.

Phase II: Implement the product of Phase I into a well-structured format and architecture which can be demonstrated within selected large-scale EW and C^3CM simulations. Develop an algorithm with a provision for effective human interaction. Simultaneously analyze the combined effects of radar, infrared, and C^3 countermeasures at the force level.

DARPA 90-123   TITLE: Knowledge Based Tools for Faster Than Real-time, Episodic Campaign Planning for Comprehensively Aggregated Levels of Discrete Simulation

CATEGORY: Basic Research

OBJECTIVE: To develop of a tool for faster than real-time evaluation of campaign plans at the executive command level that employs a knowledge-based system to support single-sided or two-sided conflict resolution.

DESCRIPTION: Current methods for evaluating echelon above wing/corps/battle group campaign plans are slow and cumbersome, relying on hundreds of supporting staff members and days of analysis to achieve minimal resolution of potential conflict situations. Application of knowledge based simulations may have the ability to support episodic campaign planning and resolve questions regarding large-scale conflicts with minimal staff support. The system envisioned will support one or two-sided operation and allow aggregation of forces and commands. The knowledge base for each of the opposing forces must sufficiently represent the operational art so that inexperienced personnel can utilize the system and stay within appropriate military practices for either force.

Phase I: Develop a preliminary concept and demonstration system. Select an appropriate method of knowledge representation, and develop and implement preliminary knowledge bases of two opposing forces. This system should demonstrate methods for aggregation of forces and commands. Faster than real-time episodic play at wing/corps/battle group level is a desirable goal for Phase I.

Phase II: Expand the operation of the system to include single-sided conflicts. Expand the level of aggregation to echelons above wing/corps/battle group levels and demonstrate faster than real-time episodic play at that level. Also add the capability to store, analyze, playback and restart the campaign analyses.

DARPA 90-124   TITLE: Artificial Neural Network Target Recognition Demonstration

CATEGORY: Basic Research

OBJECTIVE: To investigate, develop, demonstrate, and test innovative, real-time hardware techniques for implementing a new, fundamental and dynamic object extraction algorithm for target recognition.

DESCRIPTION: A basic problem of automatic target recognition is how to classify image pixels for correct grouping into candidate object regions prior to classification of objects into target types. An army-developed algorithm uniquely identifies invariant local features of images based on fundamental object properties. Implementation of this neural network-based algorithm requires innovative synthesis of hardware processing techniques. Full details of the algorithm will be furnished as required.

Phase I: Design and demonstrate a candidate hardware approach for implementing the algorithm. Show scalability to full two-dimensional imagery and to real-time operation.

Phase II: Build, as a laboratory demonstration system, a full-scale, real-time hardware system based on the results of Phase I. It should process test imagery of real scenes with actual targets. Determine the quantitative degree of the algorithm's capability to perform object extraction as measured against the known feature parameters of the test imagery.

DARPA 90-125   TITLE: Dynamic Object Extraction Preprocessor Algorithm for Automatic Target Recognition

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop, demonstrate and test innovative hardware implementation techniques for real-time hardware embodiment of a new fundamental dynamic object extraction algorithm to be used in future automatic target recognition (ATR) systems.

DESCRIPTION: A basic problem of ATR is how to classify image pixels so that they can be grouped into candidate object regions prior to further classification into type or objects such as targets or non-targets. An Army-developed algorithm uniquely identifies invariant local features of image pixels based on fundamental object properties. Implementation of this algorithm requires innovative synthesis of electronic and/or optical processing systems to develop a real-time hardware system capability to handle the algorithm.

Phase I: Design and demonstrate a candidate hardware approach for implementing the algorithm. Show scalability to full two-dimensional image processing capability and to real-time operation.

Phase II: Build a full-scale real-time hardware system. It should process test imagery of real scenes with actual targets. Conduct tests of performance and measure the quantitative degree of the algorithm's capability to perform object extraction against the known feature parameters of the test imagery.

DARPA 90-126   TITLE: Wide Dynamic Range Laser Diodes for Communications

CATEGORY: Exploratory Development

OBJECTIVE: To develop breadboard laser diodes linear to better than 1 part in 10,000.

DESCRIPTION: Current laser diodes have very limited dynamic range, usually on the order of less than 1 part in 256. In addition, this linearity is rarely achieved with any reliability and/or repeatability. The goal of this exploratory development effort is to develop laser diodes with a reliable, repeatable dynamic range of better than 1 part in 10,000.
    Phase I: Design a laser diode with the following minimum performance specifications:

> Linearity: 1 part in 10,000
> Bandwidth: 10 MHz
> Output Power: 1 watt

Emphasize those aspects which presently limit laser diode linearity and how the Phase I design can potentially overcome them. In addition, address issues related to the reliable and repeatable linear operation of a Phase I device.
    Phase II: Fabricate and test the laser diode designed in Phase I.

DARPA 90-127   TITLE: Generators (Electromechanical Power Supplies) for Miniature Reciprocating Engines (Model Aircraft Size) with Sustained Power Levels from 1 Watt to 1 Kw

CATEGORY: Exploratory Research

OBJECTIVE: To demonstrate a rugged, highly reliable, low power electromechanical power supply driven by a very small reciprocating engine (model airplane size).

DESCRIPTION: As electronics become smaller and smaller through miniaturization, our ability to fly useful electronics packages on smaller and smaller vehicles becomes limited by the weight of the required batteries and the lack of generators in the very low power range.
    Phase I: Design and demonstrate a prototype of a low power "generator" suitable for use on a small model airplane engine. The power supply range of interest is 10 watts (scalable to a few hundred watts) of DC at 12-15v.
    Phase II: Demonstrate installed performance, reliability, and scalability of a small low-power generator on a model airplane engine of suitable characteristics.

DARPA 90-128   TITLE: Passive (Nonradio Frequency/Nonelectro Optic) Sensors for Application to Low Observable Aircraft

CATEGORY: Exploratory Development/Advanced Development

OBJECTIVE: To develop brassboard sensor systems for proof-of-concept and demonstration of concept performance and effectiveness.

DESCRIPTION: Current sensor systems on conventional and low observable aircraft exploit infrared and/or radiometric information to provide passive detection of targets of interest. Technologies exist to defeat these sensors. Other types of passive systems (i.e., gravity gradiometers, electrostatic detectors, magnetic sensors, etc.) need to be explored/developed as alternatives.
    Phase I: Develop system concepts, analyze performance and effectiveness, estimate developmental costs/schedule, and possibly perform a limited sub-component test.
    Phase II: Design and test a system or a representative critical sub-component of the system as a proof of concept demonstration.

DARPA 90-129   TITLE: Low Volume, High Efficiency Power Sources for Small Satellites

CATEGORY: Exploratory Development

OBJECTIVE: To analyze and design candidate space-qualified electrical power sources for small spacecraft that have low volume and high efficiency compared to current space electrical power sources.

DESCRIPTION: All spacecraft require some type of electrical power source to operate the spacecraft systems. Spacecraft electrical power needs range from continuous/steady low power levels up to burst/high power levels. Small spacecraft may require tens of watts up to a few kilowatts of power depending on the application. Current spacecraft electrical sources are solar panels and batteries.

These systems are presently small-scale versions of electrical power source designs created for much larger spacecraft. Designs optimized for small satellites are needed. Novel ideas such as superconducting storage devices are welcome.

Phase I: Identify candidate electrical power sources that promise significant improvements in storage medium energy density and system volume and efficiency, when compared to current designs. Identify and categorize applicable components and architecture, define areas for subsequent trade-off studies, and produce development schedules and risk assessments of various systems.

Phase II: Perform trade-off studies and system architecture analysis of candidate systems that can be space-qualified and optimized for small satellite operations. Areas of concern are: survivability in the space environment, mission requirements and duty cycles, fabrication and testing issues, and development risk.

DARPA 90-130   TITLE: Innovative Thermal Control Concepts for Small Satellites

CATEGORY: Exploratory Development

OBJECTIVE: To develop and evaluate the performance of candidate innovative thermal control systems for small satellites.

DESCRIPTION: An inherent problem with small satellites is the lack of surface area that can serve as thermal radiators for the heat generated by on-board systems. The present situation restricts the power levels of small satellites to the order of hundreds of watts. This prevents small space platforms from being used for such missions as high capacity communications. Thermal control concepts that will allow small satellites to deal with higher power load heating will permit the use of this class of satellite in new areas.

Phase I: Identify alternative approaches, and develop plans for these approaches, to controlling thermal loads on spacecraft and those systems generating the most heat.

Phase II: Develop at least some of the Phase I approaches identified, and analyze their effectiveness. Include computer simulations, bench tests, control system demonstrations, and environmental testing.

DARPA 90-131   TITLE: Novel Orbital Transfer Concepts

CATEGORY: Basic Research

OBJECTIVE: To identify and understand novel concepts for aero-assisted and/or low energy orbital transfers.

DESCRIPTION: There is a need to learn about and understand new methods of performing orbit transfers and how energy orbital transfer concepts could extend the on-orbit life of small satellites and enhance overall mission utility. Aero-assisted orbital transfer concepts may facilitate new modes of operating in the earth orbit.

Phase I: Identify alternative concepts for performing orbit transfer maneuvers and provide analysis and performance criteria for subsequent efforts.

Phase II: Evaluate the performance, advantages and disadvantages of the candidate alternative concepts.

PRIOR YEARS RESULTS OF DOD SBIR PROGRAM

FY 83 - FY 88	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
ARMY	1193	9157	1093	439
NAVY	1119	7902	1035	324
AIR FORCE	1283	9408	1553	539
DARPA	135	1492	202	51
DNA	48	821	128	22
*SDIO	59	2369	540	159
	3,837	31,149	4,551	1,534**

FY 89	Number of Topics	Proposals Received	Number Selected for Phase I Negotiations
ARMY	86	997	93
NAVY	213	2233	321
AIR FORCE	257	3474	333
DARPA	47	596	100
DNA	14	213	19
SDIO	15	860	158
	632	8,373	1024**

*   SDIO began participation in FY 1985
** Awards made as of March, 1990.

TO: _____

Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 90.2
            Topic No._____
                Fill in Topic No.

    This is to notify you that your proposal in response to the subject solicitation and topic number *has been received by*

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Fill in name of organization to which you will send your proposal.

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                                   Signature by receiving organization   **Date**

To: SBIR Participants

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Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires July 2, 1990, the DoD SBIR Program Solicitation closing date.

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Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation No. 90.2.

This is our first request during the current solicitation: yes____no____.

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City--State-------Zip-------

Phone--